POWER

Established 1884—McGraw-Hill Publishing Company, Inc.
ELY C. HUTCHINSON, *Editor*

VOLUME 76 DECEMBER, 1932 NUMBER 6

EDITORIALS

"Carry Over"

Every so often one hears of difficulties with high-pressure turbine operation because of "carry over" from the boilers. While generally the results are in no sense alarming, the interruption and decrease in plant capacity are annoying.

It is with satisfaction, therefore, that men of the power field learn of the renewed energy with which the whole problem is being attacked on all fronts. New design ideas and experimental work are keeping pace with physical research.

There is so much yet to learn about "carry over" that further enlightenment is eagerly sought.

Over the Top

● PROBABLY not in the memory of the oldest inhabitant has there been such an agitating presidential campaign as the one just closed. Arguments have been as far apart as the poles and as fully opposed. It was a good fight.

● BUT IT IS all over now. The die is cast. It is time, for American sportsmanship, to shake hands, smilingly get back into the harness and pull together for the general prosperity.

● AFTER ALL, the determined workman uses what tools there are at hand, even were he to wish there were others. The instinct to build is stronger than partisanship, disappointed or otherwise.

● WE SHALL go forward confidently and without fear. Let the timid not forget that "today is the tomorrow we worried about yesterday, and it never happened."

Welding Means Thinner Pipe

Evolution continues; take pipe for example. "Standard" has a thickness far greater than needed to withstand the stresses of moderate pressures. The extra thickness provides for threading and corrosion.

But welding, now common, eliminates threading. Moreover, while corrosion danger still applies in many places, there are certain uses where there is little of it and that of little importance. Where piping is welded and used for non-corrosive applications (e.g. to carry steam), standard pipe is much thicker than necessary for moderate pressures. Conversely, for such applications, it is clear that standard pipe may be used for much higher pressures than heretofore.

For all pipe sizes above two or three inches it is already possible to produce a welded job at no greater cost (and often less) than a job with threads and flanges. The use of thinner piping for the welded installation would give it a very definite cost advantage.

The time is probably not far distant when a new "standard extra thin" pipe will be developed and made commercially available in all sizes. Such pipe should find extensive application for welded low-pressure steam lines and similar uses.

If, and when, such pipe is placed on the market, the manufacturers of welding fittings may be forced to extend their lines to provide for these new thicknesses. But any extra cost of making and carrying these additional lines will probably be overbalanced by the resulting very rapid extension of pipe welding and the greater use of welding fittings.

Hand in hand with the swing to higher unit stresses in piping, must go still more attention to materials, manufacturing methods and testing of the finished product. These will come as they always do when the need arises.

Propeller Turbine Honors Are Even

At a recent meeting of the American Institute of Electrical Engineers in Baltimore there was discussion upon the question of who should be credited with the development of the propeller-type turbine. Much can be said on either side of this question, but sober consideration should leave all interests feeling better.

A study of propeller-type turbine installations leaves little doubt that fixed-blade types are largely a product peculiar to the United States and Canada, while the automatically adjusted-blade type is preponderantly a European development.

The first fixed-blade type was installed in the United States in 1916 and the first automatically adjusted-blade type was put into operation in Europe in 1919. A record for head and power was established in 1922 when the contract was placed in Canada for two 28,000-hp. fixed-blade propeller-type turbines for 56-ft. head. About that time a contract was placed in Sweden for

the Lilla Edet adjustable-blade turbine rated at 11,500 hp. under 15-ft. head. Since then propeller-turbine records have passed back and forth across the Atlantic pretty rapidly.

About five years ago the automatically-adjusted blade turbine was introduced into the United States, and the highest powered units of that type are now installed here. In Europe, however, are the units having the largest dimensions and those operating under the highest heads.

Installed in the United States and Canada are over one and a half million horsepower of propeller-type turbines of all types, in unit sizes up to 42,500 hp. and for heads up to 65 ft. About the same total horsepower in propeller turbines has been installed in Europe in sizes up to 38,700 hp. and for heads exceeding 100 ft.

Thus, honors appear to be about equally divided for designing, manufacturing and installing over three million horsepower of propeller-type turbines in the short time of about ten years.

Tax Reduction Is Necessary

As it affects the prospects and welfare of men in the power field, and in fact nearly all others, it is distinctly our business to think of the problem of reducing heavy taxation. Politics is necessarily involved, since it is unavoidably the responsibility of the "ins" to do the job of proportioning village, town, city, state or federal administration costs to the purse of the people.

But the solution transcends politics. It is one of absolute economic necessity. As such it becomes the responsibility of everyone to urge personally the economies which will leave to the taxpayer a greater part of his earned dollar, for use in the normal ways which help to make times better.

Oil Engines Take Their Position

It appears that the oil engine, as a prime mover for the production of electric power, is commencing to acquire in this country something of the dignity and purpose it has achieved abroad.

There have been errors of omission and commission on the buying as well as the selling side. But both buyer and seller are rapidly coming to understand the foolishness of expecting power progress, without making use of the facilities that an enlightened understanding of oil engine economy offers.

Europeans have long used the diesel engine for standby and peak service, as a solution of certain types of electric utility service problems. Some utilities in this country openly concede to the diesel engine a proper place in the economic scheme of electric power production and have shaped their policies accordingly.

Other utilities are commencing to talk about the possibilities of the diesel, while still others continue to maintain a rock-ribbed attitude of irreconcilability. The "die-hards" are, however, becoming fewer in number as liberal thought, supported by an economic necessity, is given a hearing.

After all, there is no real necessity for anyone interested in the economic production of power to deny the right of the oil engine to its proper place in the scheme of things. Far-seeing executives will, in fact, clearly recognize that its aid as an electric power producer, under suitable conditions, should strengthen their position in many places.

Other forms of power generation, both steam and hydro, should welcome the oil engine to the family fireside as a blood relation in the power group, whose success will, in the long run, unquestionably mean greater success for them.

Chemical Brass Tacks

This number of *Power* gives recognition to the fact that every power engineer —like it or not—must know some chemistry. It likewise recognizes the fact that power men generally are not chemically trained and that they do not go in for this sort of thing just for the fun of it. It's a case of bread and butter rather than "bedtime stories." That is why an article herein dodges all theory and goes directly to the answer of certain feedwater problems.

Another sample of "brass-tacks" chemistry for power men is the article on the "mol." Nowadays all industrial chemists use molal computations constantly in their practical work. It is a short cut, yet most power engineers have never heard of it. To help them get dollar-saving answers with less expenditure of time and energy, this explanation of the "mol" is illustrated by an application to combustion problems, completely worked out.

Engineer Licenses from National Bureau

At a meeting of the National Council of State Boards of Engineering Examiners in New York, delegates from the states voted to approve the formation of a National Bureau of Engineering Registration which will issue to those who comply with the requirements a certificate of qualification. All but one of the state delegates agreed to urge their state boards to recognize the Bureau's certificates of qualification when passing upon applicants for state registration, and in the absence of disqualifying evidence to accept the certificate in lieu of examination.

The Bureau is already in operation, with headquarters at Columbia, S. C. To engineers wishing to practice in a number of states the Bureau should be of special benefit by minimizing the time, effort and expense of additional registration.

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POWER Stands for . .

1. Making Power When It Should Be Made
2. Buying Power When It Should Be Bought
3. Cheaper Power Through Modern Equipment
4. Easier Financing of Equipment Purchases
5. Better Use of Byproduct Heat and Power
6. Operating Methods That Save Money
7. Less Waste in Transmission and Application
8. Prevention of Smoke, Within Reason

AIR CONDITIONING

WHERE AND HOW

By P. R. RANDALL

From early beginnings in theaters and manufacturing processes, air conditioning is now looked upon as a tool of importance and necessity to industry for the improvement of human comfort and health. The general types of equipment and their fields of use are here reviewed

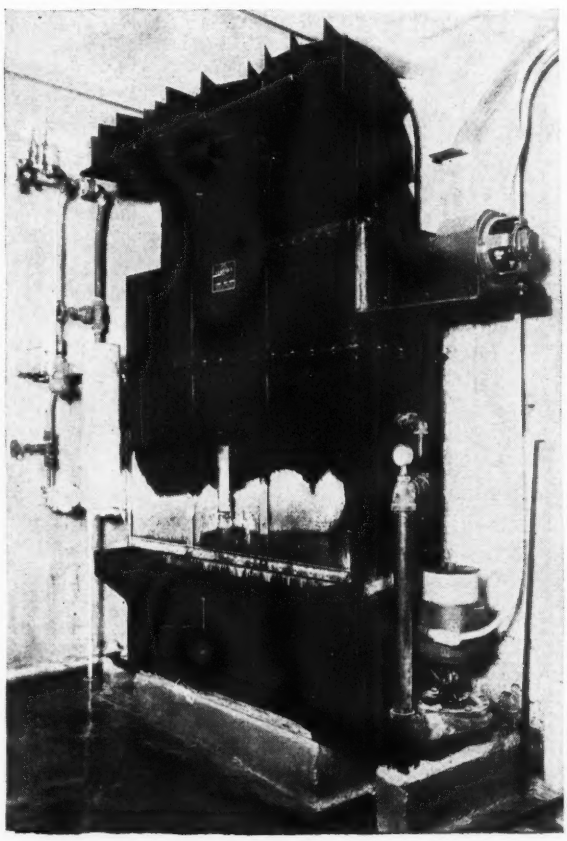


Fig. 1—This type of industrial air conditioning unit uses brine spray for cooling and humidity control

TO OBTAIN completely conditioned air the year round, the plant installed must be capable of heating, cooling, dehumidifying, humidifying, cleaning and distributing the air without causing objectionable drafts. However, in many cases the expense of complete air conditioning is unwarranted, and plants that perform only two or three of the usual air-conditioning functions need be provided. Such cases are found more often in industries where, because of process requirements, control of humidity may be of greater importance than temperature control, or vice versa.

Air-conditioning plants for comfort have generally embodied all of the six functions necessary for complete air conditioning. This is true particularly of theaters, auditoriums, hotels, etc. Where comfort conditioning only is involved, there is some doubt as to whether the expense of complete air conditioning is justified, provision for space cooling in the summer and heating in the winter being all that is necessary or justified in many cases.

With the above in mind, air-conditioning plants may be classified according to the functions they perform such as complete air conditioning, room cooling and humidifying or dehumidifying. A second classification would be unit conditioners and central systems.

Central air-conditioning systems generally are designed to produce fully conditioned air. They consist of water spray chambers through which the air passes. The water used in the spray during the summer should be at temperatures ranging between 45 and 55 deg., depending on weather conditions. The air, in passing through the spray, is cleaned and cooled to very nearly the temperature of the spray water. During the summer the process not only cools the air but dehumidifies it. The air, being saturated with water vapor at the low temperature existing as it leaves the air washer, will have a relative humidity of 40 to 50 per cent when its temperature increases in the space being conditioned.

The spray in the air washer is generally produced by nozzles through which the water is pumped at pressures in the neighborhood of 30 lb. One air washer, however, produces a spray by causing a stream of water to impinge upon an impeller driven at high speed by a totally inclosed and water-proof motor. A typical air washer for a central system is shown in Fig. 2.

When ice is used to cool the water there is a trend toward elimination of the spray and the substitution of fin-type coils through which the cold water is pumped. This arrangement will eliminate one pumping operation, but when complete air conditioning is desired during the winter a water spray should be introduced for humidifying.

Heating coils are provided both before and after the air washer. The coils before the washer heat the

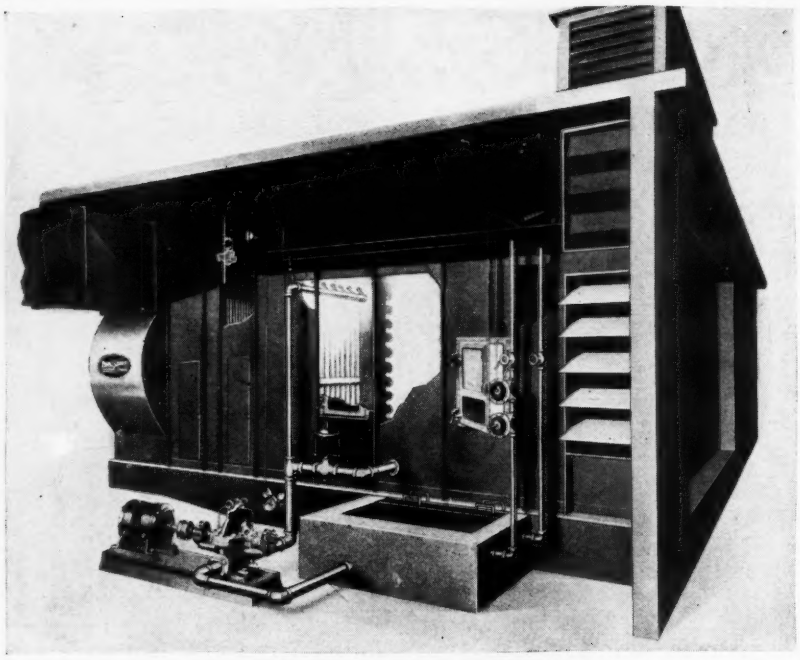


Fig. 2—Air is conditioned in a central air washer and delivered by fan and ducts to the various rooms

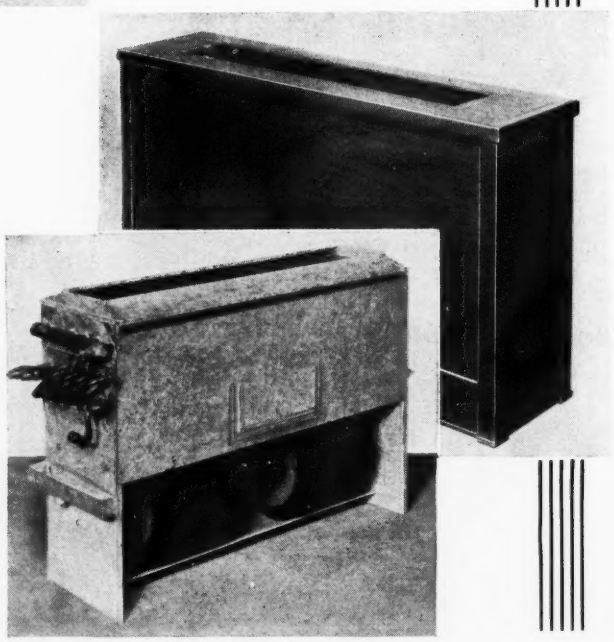


Fig. 3—Units of this type for use under windows embody cooling and heating coils, spray for humidification and fans

incoming fresh air enough to prevent freezing of the water. The coils after the washer are used in the winter for heating and at certain times in the spring and fall when, to secure proper humidity conditions, it is necessary to cool the air to such an extent that it would create an uncomfortable low temperature unless reheated before delivery to the conditioned space. The use of tempering coils for this latter condition can be practically eliminated by passing return air into the discharge from the washer in sufficient quantities to warm the air supply to the required temperature. It is common practice to recirculate air from the conditioned space and to provide only 30 to 50 per cent fresh air. This procedure saves refrigeration during the summer and heat during the winter. When the conditioned space has objectionable odors, such as in restaurants or in industrial processes, it may not be advisable to recirculate to such an extent.

Recently there have been developed a large number of air-conditioning units. In general, these are not designed to produce complete air conditioning, but are for room cooling and some dehumidifying in the summer and for heating in the winter.

Such units are designed in general for use in relatively small spaces and in isolated rooms. By using a number of units, however, large areas can be conditioned. They are so used when it is impracticable to run ducts for supply and return air. A more recent use for unit conditioners is in individual offices of modern office buildings and in residences.

There are many types of unit conditioners, including units with spray heads, radiator cabinet types, units with cooling and heating coils and unit heater types. Fig. 1 shows a typical industrial-type unit for conditioning cold storage rooms. Units of this type have spray heads, heating coils, fan pumps and control all included in the cabinet. In other similar units, cooling coils replace the water spray. The coils may be used with direct expanding refrigerant or with circulating brine or water. When used to produce temperatures below freezing, as in cold storage rooms, a defrosting feature is provided. Conditioners with cooling coils will furnish cooled and dehumidified air when supplied with sufficiently cold circulating water or brine, but will not humidify the air when used for heating during the winter months unless a drip- or spray-type humidifier is added. The absence of winter humidification should not in general mitigate against their use, as the resulting room conditions produced will be about the same as that existing when a direct heating system is employed.

Unit heaters, which have proved economical for industrial heating, have been redesigned for use as combination heating and cooling units. In some units this merely involved provision of a drip pan to catch and dispose of the water condensing on the cooling coils. The unit shown in Fig. 5 has been provided with a float for use with the direct expansion of ammonia or other refrigerant. A new model is being developed by this manufacturer with which a synthetic liquid will be used

that can be heated in the winter for space heating and cooled during summer for comfort conditioning.

Dehumidifying with chemicals has proved practical and is particularly applicable where very low humidities are necessary to meet process requirements. This system, however, is not confined to industrial processes but is also being used for comfort air conditioning in office and public buildings where comfort conditions are produced by decreasing the humidity in combination with moderate cooling.

One such system utilizes the properties of silica-gel, which is capable of absorbing large quantities of moisture from the air much like a sponge absorbs water. After the silica-gel becomes saturated it may be reactivated by heating, which drives off by evaporation the water it has absorbed.

A silica-gel conditioning unit consists of silica-gel beds, air heaters for reactivating the gel, a fan, cooler, air filter and automatic controls. Fresh air is drawn through the filter and delivered to the beds of gel which remove the moisture from the air. The dried air then passes through the cooler to the conditioned areas. When the gel becomes saturated it is reactivated by heating to about 350 deg. with hot air, the cycle of absorption and reactivation being controlled automatically.

Both central systems and unit air conditioners using silica-gel are available and are capable of producing relative humidities as low as half a per cent.

Another system similar in principle makes use of the hygroscopic and deliquesent nature of calcium chloride. The unit now developed consists of a metal box which holds a solution of calcium chloride. Thin steel disks covered with turkish toweling are arranged to dip into the calcium chloride solution and to revolve at about 6 r.p.m. Air is drawn through between the disks, and in passing water vapor is absorbed by the film of solution on the toweling. As the volume of the solution increases due to condensation of moisture from the air, the solution overflows to the sewer.

For summer air conditioning, either an inexpensive supply of cold water is necessary or else refrigeration must be employed to cool the water used in the air washer or cooling coils. Compression refrigeration using ammonia, carbon dioxide, and methyl chloride have been used extensively for this purpose. Self-contained refrigerating units of small capacity such as shown in Fig. 4 are now available for use with unit conditioners. Such units are automatic in their operation and therefore require a minimum of operating attention.

More recently, ice is being used for water cooling. This is found economical where the period of cooling is relatively short, the cost of ice being offset by the decrease in fixed charges due to greatly decreased first cost. When ice is used it is stored in insulated bunkers generally large enough to hold a day's supply. Water is sprayed over the ice and then pumped to the air washer sprayers or through cooling coils.

Air conditioning has resulted in a new interest in vacuum refrigeration using water as the refrigerant. This system is adapted to conditions requiring moderately low temperatures such as encountered in air conditioning and may be used to advantage when steam at a few pounds gage and up is available.

This system operates by producing a vacuum over the water to be cooled, causing water to boil, so removing heat from the remaining water and reducing its temperature until the temperature corresponding to the existing pressure is reached. For air conditioning absolute pressures of 0.3 to 0.45 in. Hg. are required and may be produced by using steam jets and condenser.

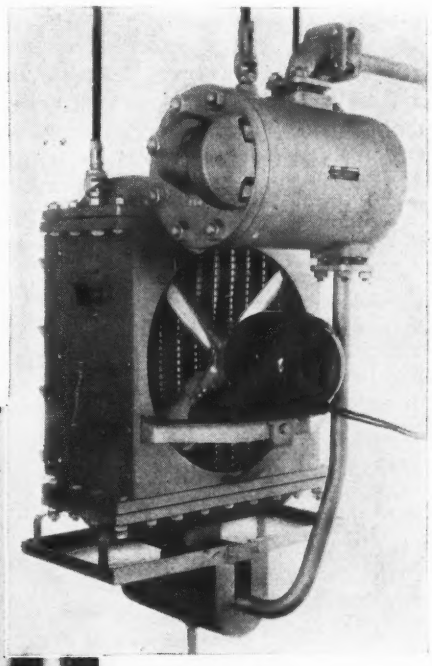


Fig. 5—Unit heaters have been redesigned for use in room cooling. The manufacturer of this unit is developing a new type, pictures of which are not yet available

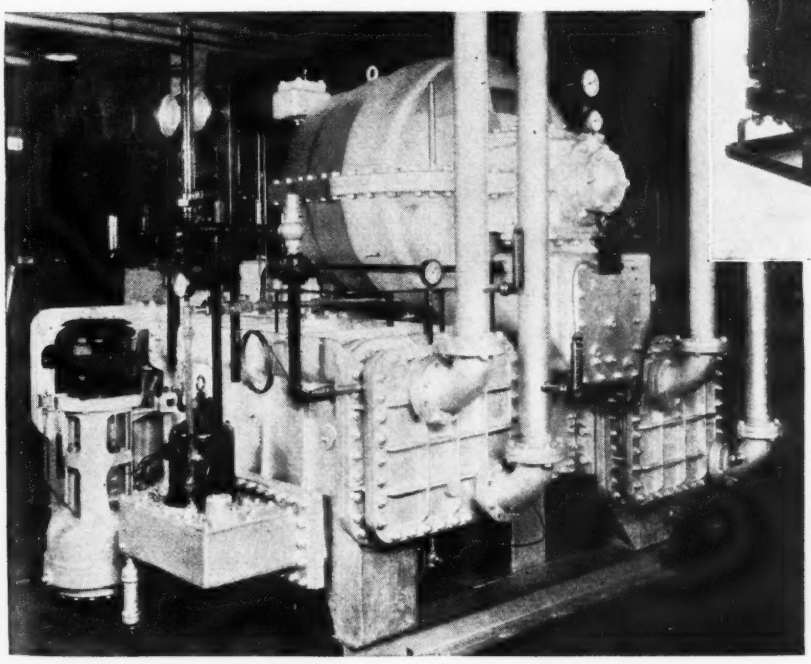


Fig. 4—Complete refrigeration systems in single units are available in both large and small capacities and embody automatic features

AIR CONTROL STEPS UP

Thirty per cent increase in continuous steaming capacity and improved efficiency achieved by sectionalized control of air to underfeed stokers at Beacon Street

By J. H. WALKER
Supt. of Central Heating,
The Detroit Edison Co.

HIGHER combustion rates are an important objective in stoker development. By burning more coal per square foot of grate area, not only can the size of the stoker be reduced but often the floor area of the entire boiler room can be decreased.

In every installation there is ultimately some element limiting the steam output of the boiler unit. It may be something inherent in the stoker or something entirely apart from it such as insufficient fan capacity or restricted steam outlet piping. Considering the stoker itself, there is always some limit to the attainable combustion rate. Experience with a method of sectionalized air control at the Beacon Street heating plant has thrown much light on the question, and made possible an increase of 30 per cent in the maximum continuous steam output of the boiler units, along with a slight improvement in efficiency at all loads.

At the Beacon Street plant all auxiliaries and elements of the boiler units are designed with ample margins of capacity. The coal used has an ash of high melting point so that the formation of serious clinkers, which sometimes limits stoker performance, is not a factor here. The steam output of each unit is therefore limited only by the coal that can be burned.

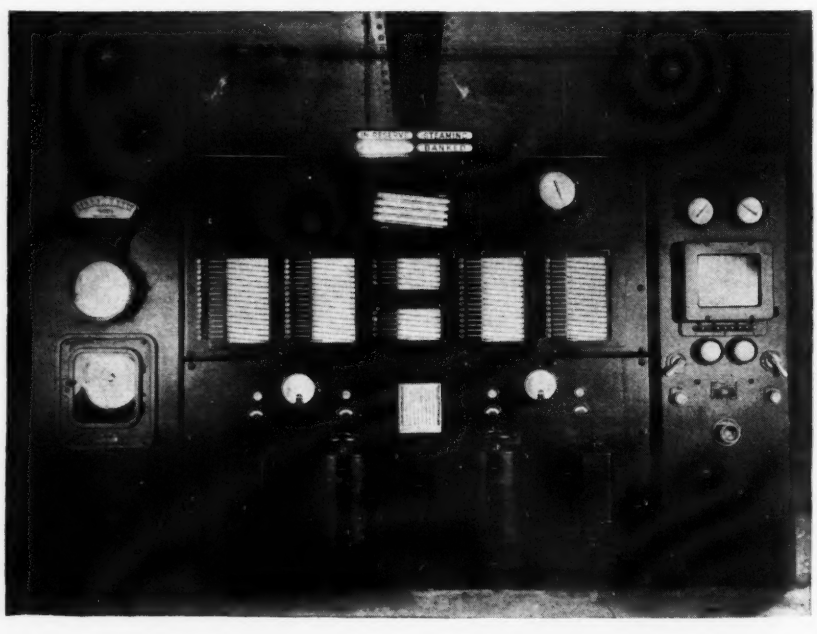
The nature of the load curve in a district heating system is such that the top load must sometimes be maintained continuously for several hours. It is not a sudden, short peak. The important steam output figure is, therefore, the continuous output; good for six or eight hours, rather than any instantaneous or short-time performance.

It was interesting to observe, as the combustion rate was progressively increased, exactly what happened in the furnaces before the installation of air control. As the fuel burning rate approached 60 lb. per sq. ft. per hr.[1] there was a marked increase in the quantity of fine coke blown from some parts of the fuel bed to form drifts in other parts. With a further increase in combustion rate and consequently in under-fire air pressure, this condition became steadily worse, until finally certain areas of the stoker appeared to be almost bare while in other places the fuel piled mountainously high. No further increase in combustion rate could be obtained, and in fact steam output gradually dropped.

That the tuyere openings throughout the stoker are of uniform size may have led to the unsound assumption that the air distribution is likewise uniform. This would be approximately true if the resistance imposed by the tuyeres to the flow of air were the controlling factor in the air flow, but it is not. At maximum output at Beacon Street the total differential between plenum chamber and furnace pressures is about 6.1 in. of water. Of this only 0.45 in. is pressure drop through the tuyeres, the remaining 5.65 in. being almost entirely pressure drop through the fuel bed. The air distribution is thus controlled by *fuel bed resistance* rather than by the size of the tuyere openings, and variations in fuel bed resistance at different points mean unequal distribution of air.

Recognizing this fact, it is not difficult to find an explanation for the observed fuel bed disturbances. The upsetting process probably starts at some point in the fuel bed (which is never entirely homogeneous) where

Fig. 1—The slant gages in the center of the control board indicate the air-flow conditions for the extension grates; the two sets of gages either side of the center show the air-flow conditions for the upper and lower zones of the north and south stokers



[1]Coal burning rates are per sq.ft. of projected grate area per hour, including area of grinder pit.

STOKER PERFORMANCE

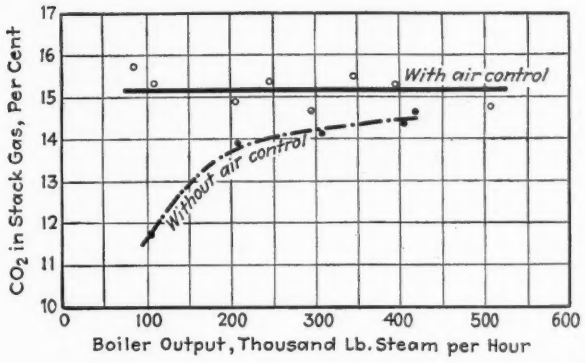
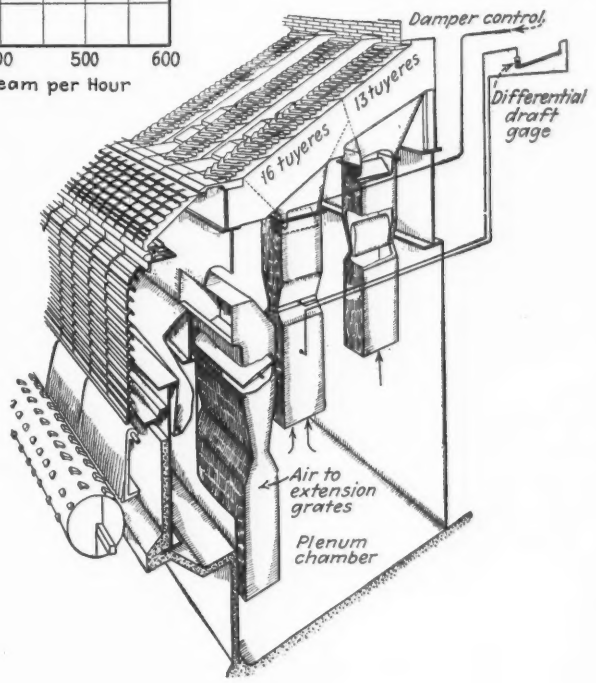


Fig. 2—Excess air, as shown by CO_2 readings, was appreciably reduced

Fig. 3—The air control consists of air flow meters and dampers applied to subdivisions of the fuel bed



there is a slightly decreased resistance and, therefore, a slightly increased flow of air. This in turn causes a locally increased combustion rate. The fuel bed at that spot, therefore, tends to burn thin and the flow of air through that area is further increased. The thin spot presently becomes a hole that cannot fill up because of the blast of air from the tuyeres, and large pieces of coke are blown to other parts of the furnace. Simultaneously in another part of the furnace the reverse of this action may be taking place, the fuel bed becoming locally thicker and the air flow becoming cumulatively restricted. In a large furnace the process, if allowed to continue, results in an extreme amount of unevenness and eventually renders the fire totally unmanageable.

Obviously, a high combustion rate cannot be maintained under such conditions. This extreme disrupting process requires a certain time for completion, varying from a few minutes to an hour or more, which explains why it was often possible to carry high combustion rates for short periods, but not for satisfactory lengths of time.

At high combustion rates changes in the fuel bed take place rapidly, and when no air control is installed the unbalancing is always well under way before it can be observed by the operator, who normally must depend upon visual inspection of the fire. The air control gives the operator immediate warning of incipient unbalancing, before it could possible be observed by inspection, and provides him with a simple means of correcting it.

Sectionalized Air Control

The basic idea in sectionalized air control is to adjust the air flow to each small subdivision of the fuel bed independently of changes in fuel bed resistance. A local thinning of the bed does not cause an increased flow of air because flow is controlled, and progressive unbalancing of the fuel bed cannot even start.

Control of the air supply is accomplished by dividing the stoker checkerboard-wise into small areas, each of which is supplied by a short duct containing a damper and a simple device for indicating the air flow. The boiler operator, by observing the air flows and adjusting the dampers, is thus able to maintain the proper flow of air to every part of the furnace regardless of variations in fuel-bed resistance. When the air-flow indicator shows an abnormal increase in air flow to any one section, he simply checks the damper for that section and, if necessary, increases the fuel supply to that retort, permitting the fuel bed to build up again. Conversely, if he sees that the air flow is deficient at any point, he opens the proper damper a little wider. The normal air flow for each zone of the fuel bed has been predetermined for various steam outputs.

Sectionalized air control has made it possible to step up the dependable continuous performance of the Beacon Street boilers as follows:

	Without Air Control	With Air Control
Steam output — Lb. per hour	407,000	534,000
Combustion rate — Lb. coal per hr. per sq.ft. of projected grate area including pit	59.2	77.7
Heat release — B.t.u. per hr. per cu.ft. of furnace volume	31,300	41,100

Air control has made possible a considerable reduction in excess air particularly at light loads. It has been fairly easy to maintain an average CO_2 reading of 15 to 15.5 per cent at all loads between 80,000 and 534,000 lb. per hour without smoke or unburned combustible gases, as shown in Fig. 2. The reduction in excess air increases the efficiency, as calculated from a series of heat balance tests (not evaporation tests) by ½ per cent at high loads and about 2 per cent at low loads. The comparison is made against careful tests on a boiler not equipped with air control. At Beacon Street even with its poor annual load factor, this increase in test efficiency,

[1]Articles on the Beacon Street plant appeared in the following issues of *Power;* June 23, 1931, Jan. 31, 1928, July 19, 1927, Nov. 23, 1926.

if ultimately borne out by actual operating results, would probably justify the installation of the control. From the standpoint of increased steaming rate, the control is a handsome investment.

Physically, the air control apparatus is relatively simple. The 29-tuyere stoker is divided into three zones, the third zone comprising 13 tuyeres, the lower zone 16 tuyeres, and the third zone consisting of the moving and stationary extension grates. The upper and lower zones are subdivided corresponding to the tuyere stacks, there being 15 sections in each zone for the 14-retort stoker. The extension grate zone, because of structural conditions in the stoker, is divided into only four sections. Thus there are 34 subdivisions, or 68 for the entire double stoker.

Each section has its damper and its air-flow measuring device, the latter consisting of a venturi tube to which is connected a differential liquid type slant gage.

Because of the wide range of steaming rates of the Beacon Street boilers, some provision is necessary to obtain a readable venturi differential at low rates of air flow. In the latest installation this is accomplished by means of a movable throttling plug. For low rates of flow the plug is moved, by a simple mechanism, into the throat of the venturi tube, decreasing the effective throat area and thus increasing the venturi differential.

The control board, Fig. 1, contains the slant gages arranged to correspond approximately to a plan view of the furnace. The operator can thus, by observing the gages, readily visualize what is taking place in the furnace. Opposite each slant gage is the knob that operates the corresponding damper by means of a flexible sheathed wire similar to a carburetor choke control. The gages are calibrated in terms of boiler output so that, for a given steaming rate, the operator knows what the average air flow should be. A Smoot system of automatic combustion control regulates the *total* quantities of air and fuel.

On the whole, observation indicates that where the proper operating care is given and there are no other restricting actors, sectionalized air control should raise the limiting coal-burning rate of an underfeed stoker by an amount that will more than justify the first cost of the control.

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Every power engineer is interested in the debates that center around the relative merits of flanged and welded piping. From the standpoint of a user favoring welding, Mr. Johnston argues particularly for the use of welding fittings as cheaper and better

BETTER PIPING AT LOWER COST WITH

WELDING FITTINGS

By W. J. JOHNSTON
Mechanical Engineer

WELDING fittings, now available in various styles, have passed through the experimental stage of design, metal choice, fabrication and application. The hour reached the stage of mass production, so that quick delivery can be obtained in any part of the United States. They represent an advance in the art of designing and fabricating piping systems.

Engineers and contractors should, therefore, make greater use of welding fittings in solving the many problems arising in the layout and installation of piping for all purposes. Some of the advantages offered are here enumerated, and a comparison of their cost with that of the older type of construction is made.

In detailing the work in the drafting room the fewer flanged joints decrease the work of taking off bolting material quantities. Clearances may be minimized as there are no flanges for which to provide. Parallel pipe runs can be nested closer together, as no space is needed for manipulating wrenches in making up joints on maintenance work after the initial erection.

The smooth internal surface, uniform contour of the bore and smooth junction of a welding fitting with an adjacent straight pipe give a lower pressure drop than in the case of a cast fitting. The radii to which welding fittings are made allow a gradual, easy change in the direction of the flow of the fluid.

At present welding fittings give more metal thickness in the wall than is required for the working pressure. The thickness of the walls follows closely that of pipes wherein the metal of the walls is increased to compensate for threaded ends. Since none of the metal of a welding fitting is removed in a threading operation, the extra

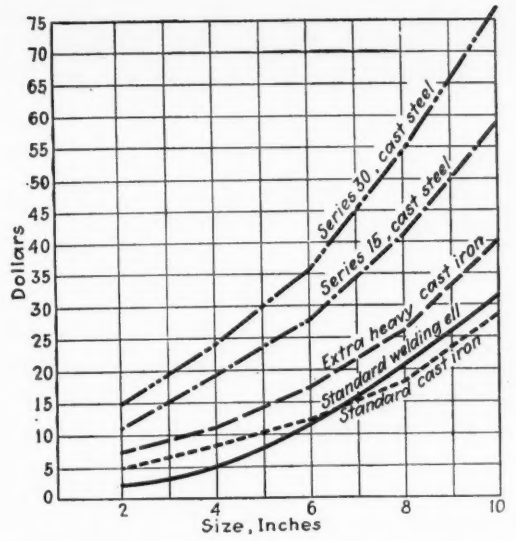

Fig. 1—Comparative installed costs (including material and labor) of standard welding ells and comparable flanged ells

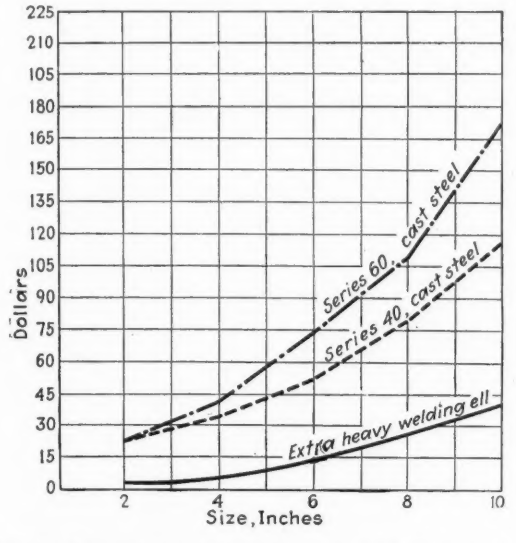

Fig. 2—Comparative installed costs (including material and labor) of extra heavy welding ells and comparable flanged ells

metal is available to withstand the working pressure, and unit stresses are decreased. Either one of two possibilities will occur in the future; (a) the wall thickness of welding fittings will be decreased for a given working pressure, or (b) the present wall thickness will be retained and the working pressure increased.

Screwed or flanged joints in a piping system are regions of localized stresses because of the break in the continuity of the structure. If the design of a welding fitting places the weld where the direction of the piping structure is changed. that is from a straight line into an arc of a circle, the weld is subject to the high stresses localized at that point. A design of fitting providing tangents at the ends of the arcs removes the circumferential weld from the high stress zone. It also facilitates aligning the fitting and piping and increases the welding speed.

Decreased cost of fabrication and installation offers the greatest economy in the use of welding fittings. They are purchased ready for immediate use. The adjacent lengths of pipe are shipped with ends machined to a bevel for welding. There is no need for threading and flanging the pipe. No bolting material or gaskets are required on the job, and expense is saved in furnishing extra quantities of each to compensate for field losses. The weight of material handled in erection is decreased. Less time is required for erection, and the labor involved, always a large item, is materially reduced.

The computed costs of furnishing and connecting standard and extra-heavy welding fittings and flanged elbows ranging from the standard cast-iron weight to Series 60 cast steel have been plotted in the accompanying curves. It is evident that welding fittings are less expensive except in the case of 8-in. and 10-in. cast-iron elbows. In these instances the slightly increased cost can be justified because of the greater permanence of the welded versus the bolted joint, which obviates the possibility of cast-iron flanges snapping off due to line shocks.

In computing the costs, the material for the welding fittings includes the fitting itself, the welding rod, oxygen and acetylene. For the bolted fitting, the cost includes the fitting, two flanges, two gaskets and two sets of bolts. Standard cast-iron companion flanges were used with standard cast-iron flanged elbows, extra-heavy cast-iron flanges with corresponding, elbows and forged-steel flanges with Series 15, 30, 40 and 60 cast-steel elbows. Up to and including Series 30, common machine bolts were figured, but for Series 40 and 60 alloy-steel studs, in accordance with A.S.T.M. Specification A 96-27, Class C were used.

Installation Labor

The labor for the installation of the welding fitting includes only the actual welding time for one man and one helper. The labor for installation of the flanged fitting includes the time for threading and making two screwed flanges on a regular pipe machine (not a portable) and the time for bolting up two flanged joints with the same number of men and at the same rate of pay as figured for the welding fitting.

None of the costs include any time for transporting the material to the point of installation nor time for hoisting into place. Had this time been considered, the advantage would have been in favor of the welding fitting, since it is so much lighter than the cast fitting.

The advantages of welding fittings, interpreted broadly, are briefly:

a. Stock and random lengths of pipe can be used.
b. Investment in pipe threading and flanging equipment unnecessary.
c. Bevel-ended pipe costs less than threaded or Van Stone ended.
d. No excess fittings nor scrap pipe remains upon completion.
e. Heat insulation of lines costs less, as there are fewer flanges to cover.
f. Maintenance of screwed and flanged line joints is avoided.

Good piping practice calls for the more extensive use of welding fittings and welded pipe fabrication because of a better, permanent construction, less material weight involved, greater efficiency, lower maintenance expense and a more economical investment.

LIME—PHOSPHATE—SODA HOW MUCH?

By WILLIAM J. RYAN

Water Service Laboratories
New York City

EDITORS of technical papers frequently receive letters from their readers asking how to figure out the amount of chemicals required for treating the feed water. This article will show how to calculate, from the analysis of the water, the required amounts of the principal chemicals used, by means of certain formulas and a certain amount of arithmetic. Two sets of formulas will be given for the two forms of analysis that are generally used.

The Analysis

A typical water analysis, according to a form that is widely used, would look like this:

	Parts per Million
Total hardness (as $CaCO_3$)	160.
Calcium hardness (as $CaCO_3$)	105.
Magnesium hardness (as $CaCO_3$)	54.
Alkalinity (as $CaCO_3$)	116.
Sulphates (as SO_4)	62.
Chlorides (as Cl)	12.
Carbon dioxide (CO_2)	30.

There will be other items in the analysis, but they can be omitted here, as they have no important relation to the required amount of chemical treatment.

Lime and Soda

If this water is to be given a cold treatment with lime and soda-ash, the pounds of commercial chemicals theoretically required per thousand gallons of water can be figured from the following:

$$\text{LIME} = \frac{\text{Alkalinity} + \text{Mag. hardness} + (2.3 \times CO_2)}{145.8}$$

$$= \frac{116. + 54. + (2.3 \times 30)}{145.8}$$

= 1.64 lb. (of commercial "90 per cent" lime) per 1,000 gal. of water

$$\text{SODA-ASH} = \frac{\text{Total hardness} - \text{Alkalinity}}{113}$$

$$= \frac{160. - 116.}{113}$$

= 0.39 lb. per 1,000 gal. of water

If the water is to be treated in a hot lime-soda softener, the "$2.3 \times CO_2$" can be omitted from the lime formula. With hot or cold treatment the amount of chemicals actually used will be subject to some adjustment according to the results obtained.

If internal treatment is to be used with this water, using soda-ash alone, the theoretically required amount can be figured from the same soda-ash formula given above. To this must be added a certain excess. The amount of excess soda-ash necessary to prevent deposits of hard scale can be determined by experience in each case, using periodic analyses of the blow-down water as a guide.

Phosphate

If internal treatment with TRI-SODIUM PHOSPHATE is to be used, the required commercial phosphate to react with the hardness in the water can be figured thus:

$$= \frac{(\text{Total hardness as } CaCO_3 \times 2.5)}{120}$$

which in this case:

$$= \frac{160. \times 2.5}{120}$$

= 3.33 lb. per 1,000 gals.

If DI-SODIUM PHOSPHATE is to be used the required amount will be

$$\frac{\text{Total hardness as } CaCO_3 \times 2.38}{120}$$

which in this case:

$$= \frac{160. \times 2.38}{120}$$

= 3.18 lb. per 1,000 gals.

Ionic Analysis

The analysis of the same identical water could be expressed in a different way according to the custom of the chemist. The water whose analysis is given above could also be described in the "ionic" form thus:

	Parts per Million	Equivalents per Million
Calcium (Ca)	42.	2.1
Magnesium (Mg)	13.	1.07
Sodium (Na)	17.	....
Bicarbonate (HCO_3)	142.	2.33
Sulphate (SO_4)	62.	....
Chloride (Cl)	17.	....
Carbon dioxide (CO_2)	30.	1.37

This analysis looks different, but it is merely a different form of expression and a chemist could tell immediately that it was the same water. Note that after the quantities of calcium, magnesium, bicarbonate, and carbon dioxide, there are given in the second column the "equivalents per million." The equivalent of each item is the weight of that material which enters into a combination containing 1 atom of hydrogen. It is neces-

sary to have the figures for the equivalents per million in order to figure the lime and soda ash without involved calculation, so when a chemist reports a water analysis in the above form, he should be requested to include the equivalents per million.

Lime

It should be noted here that the equivalent of lime is 41.1 (the 90 per cent commercial lime) and the equivalent of soda ash is 53.

The required lime can be figured from the analysis by the following formula:

Pounds of Commercial LIME per 1,000 gal. of water.

$$= \frac{(HCO_3 \text{ equiv.} + \text{Mg. equiv.} + CO_2 \text{ equiv.}) \times \text{lime equiv}}{120}$$

Substituting in the formula, the values from the analysis, the required LIME

$$= \frac{(2.33 + 1.07 + 1.37) \times 41.1}{120}$$

$$= 1.64 \text{ lb. per } 1{,}000 \text{ gal.}$$

which gives the same result as the other analysis and the other method of calculation.

Soda

The formula for soda-ash is:

Pounds of SODA-ASH required per 1,000 gal. of water

$$= \frac{(\text{Ca. equiv.} + \text{Mg. equiv.} - HCO_3 \text{ equiv.}) \times \text{soda-ash equiv.}}{120}$$

Substituting in the formula the items from the analysis,

$$\text{SODA-ASH} = \frac{(2.1 + 1.07 - 2.33) \times 53}{120}$$

$$= 0.37 \text{ lb. per } 1{,}000 \text{ gal.}$$

which checks practically, with the other system of analysis and calculation.

Tri-Sodium Phosphate

Tri-sodium phosphate requirement is computed as follows:

TRI-SODIUM PHOSPHATE required to combine with hardness in the water

$$= (Ca \times 0.053) + (Mg \times 0.087)$$

which, in this case,

$$= (42. \times 0.053) + (13. \times 0.087)$$
$$= 2.23 + 1.13$$
$$= 3.36 \text{ lb. per } 1{,}000 \text{ gal.}$$

which checks, practically, with the required amount as determined from the other form of analysis.

Di-Sodium Phosphate

Required DI-SODIUM PHOSPHATE

$$= (Ca \times 0.049) + (Mg \times 0.082)$$
$$= (42. \times 0.049) + (13. \times 0.082)$$
$$= 2.06 + 1.07$$
$$= 3.13 \text{ lb. per } 1{,}000 \text{ gals.}$$

which also checks, practically, with the amount as calculated from the first form of analysis. The slight differences in the results are simply due to dropping some decimal fractions.

It should be noted that the foregoing formulas for calculating phosphate and soda-ash for internal treatment give the quantities of chemicals required to react with the hardness in the water in order to form calcium phosphate or calcium carbonate instead of calcium sulphate. In addition to the theoretically required amount of chemicals, there will always be required a certain "excess," the amount of said excess to be determined in each case by experience.

In addition to the two forms of analysis referred to above there is a third form, known as the combined form, giving quantities of calcium bicarbonate and calcium sulphate, etc., obtained by combining the amounts of Ca, HCO_3, SO_4, etc. as actually determined. This form is not the best one to use as there is a lack of agreement among chemists as to the method of making the combinations.

At this point, it should be stated that the proper choice of treatment for a water such as described herein will depend on the relative costs and on the operating conditions. In a plant having a high percentage of make-up or operating at a high rating, internal treatment of such a water would probably cause too much deposit in the boilers, and external treatment would be preferable, supplemented by some internal treatment if necessary.

A PRACTICAL ANSWER

A reader writes: "I see a lot of articles on feedwater treatment, but they don't tell me directly how to figure the amount of lime and soda required for treating water. Where can I find out?" Here is Mr. Ryan's answer, prepared at the request of *Power*. It gives the answer, not only for lime and soda, but also for trisodium and disodium phosphates. No theory — brass tacks and nothing else

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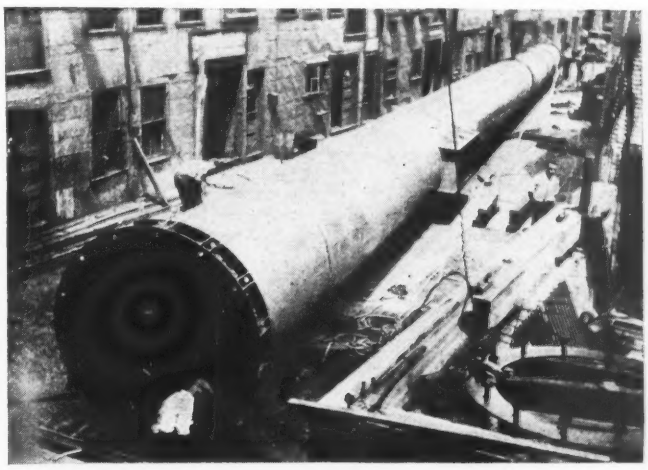


Welded construction was used on this 140-ft. self-supporting stack for the T. wharf power house of Quincy Market Cold Storage Co., Boston, Mass. It is 6½ ft. in diameter at base, tapering to 5 ft., is of ⅜ and ¼-in. plate, and weighs 25 tons. Fabricated by James Russell Boiler Works with Lincoln "Fleetweld" equipment

ELASTIC SUPPORTS PREVENT

Rotating machines can be made quiet within certain limits. Below these, dependence must be placed on sound isolation methods to prevent these noises being transmitted through building structures

By C. C. CLYMER
Industrial Engineering Department
General Electric Company

SOUND control and sound measurement in building structures is assuming a rôle of major importance, as evidenced by the committees appointed by various engineering societies to study this problem. In a building any sound above a certain level is certain to prove objectionable. It is, however, ridiculous to write specifications calling for "noiseless machines," "absolutely quiet machines," or machines to operate "satisfactorily quiet," or to the satisfaction of a given individual. What one individual may accept as satisfactory may be entirely unsatisfactory to another. No machine can be made absolutely quiet. Moreover, such noises and sounds as may be present can be amplified so that they become objectionable.

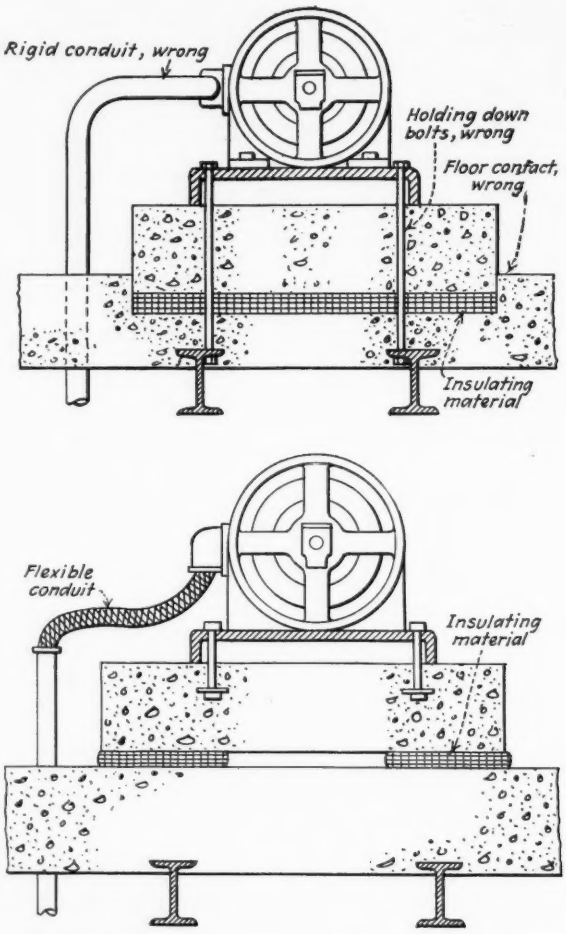
A better specification would call for a machine that will not raise the noise level of the standard-noise room above a specified numerical value. The table shows the nature of sounds on the decibel noise scale. Specifications could cover a machine which would not raise the noise level of the room beyond 42 decibels when operated at rated load or under anticipated load conditions. Manufacturers of machinery would thus have a reference point, and so would purchasers and ultimate users.

Machines that are satisfactory in one installation are causes of complaint in another. A comparison of a quiet installation and a reputedly noisy one revealed that the machines were as identical as could be expected of commercial products. The noise emitted by the two machines was substantially identical; therefore, it is reasonable to suppose that part of the trouble at least may be ascribed to causes over which the machinery manufacturer has no control, such as the building structure, the location of the machinery and the method used in placing the machine in the building.

It is not the intention here to absolve the machinery manufacturer from all responsibility. Machinery manufacturers must continue to improve their products. On the other hand, if it is economically possible to effect improvements by suitable installation and building construction, they should be employed to the fullest extent.

Rotating apparatus operating at speeds from 50 to 1,800 r.p.m. cannot be made to operate without noise, even neglecting economic considerations. Noises are usually of two forms—mechanical and electrical vibrations —and like heat are carried away from the location where they are generated by conduction, convection (air borne), and by reflection.

Sound that is carried by conduction requires physical contact between the disturbing and conducting medium.

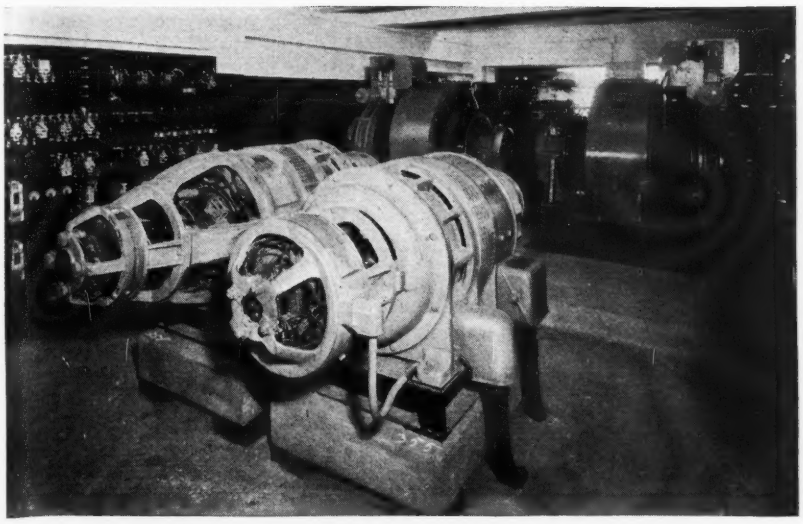


Above—Wrong way of attaching machine to its foundation to prevent noise transmission. Below —Correct way of attaching machine to its foundation to prevent noise transmission

Thus, if steel laminations vibrating with a frequency of 60 cycles are in direct contact with a steel-frame building girder, these vibrations will be conducted to all parts of the structure. Should a section of the building have a natural period of vibration approaching the frequency of the laminations, the amplitude of the vibration is magnified and the maximum disturbance occurs at that point.

One office building had motor-generator sets installed in the 27th floor. These caused no disturbance on the upper floors of the building, but on the seventh floor sev-

MACHINE NOISE TRANSMISSION



Machines should be mounted on elastic supports to prevent their vibrations from entering the building's structure

eral of the rooms were untenable. The difficulty was corrected by breaking metallic contact between the machines and building frame.

On another installation, an elevator machine was giving trouble when accelerating and stopping. The machine's critical speed was approximately one-third of rated speed. At rated speed and rated load, the installation was quite quiet. The remedy for this trouble was to design an elastic mounting to be effective around 27 cycles. Of special interest on this installation was the fact that no unusual noises were present in the penthouse. Certain locations in the building were, however, practically untenable. The experience is not unusual, and indicates the importance that construction features have.

In elevator installations where quietness in operation is essential, the hoistway should not extend to the penthouse floor. A chamber should be provided over the hoistway where the safety governor may be mounted. Covering the ceiling of this chamber with a sound-absorbing material will assist in preventing reflection of any noise that may enter the chamber.

Air columns may have a natural period of vibration, which will allow them to resonate with the disturbing or impressed frequency. If the air columns extend into occupied sections of the structure, trouble results. Again the air may vibrate against a partition, and this vibration can be conducted away. Hard, smooth walls also reflect noise. Where elevator hoistways connect directly with the penthouse, a hard ceiling will reflect noises down them, with annoying consequences. Air-borne noises should be confined to their source and hard smooth walls avoided, as they will amplify and reflect noises that may be present.

Noises transmitted by conduction can be isolated by placing the machines on some form of elastic mounting to prevent the vibrations from entering the building structure. This elastic mounting must not be a resonant substance, which distinguishes it from the building structure, in practically every instance composed of resonant materials. Air-borne noises can be confined to their place of generation by suitable treatment of the walls and by avoiding direct air passages between the machinery room and occupied sections of the building. The importance of this feature cannot be over-emphasized. A test was made of a sound-absorbing material used as a partition between two rooms and the material was found to be very effective for the purpose. However, a $\frac{1}{4}$-in. hole drilled in the partition nearly nullified the effect of the insulation.

Conduit should not be attached rigidly to motor-generator sets mounted on cork supports. In a hotel that came to the writer's attention the conduit was attached rigidly to the motor-generator set. A false ceiling of the upper floor was in places supported by steel hooks from this conduit. This made an ideal loud speaker, and made several rooms untenable. Disconnecting the conduit from the set overcame the trouble completely.

The fact that sleeve bearings operate on a film of oil, wheras anti-friction types maintain a direct metallic contact, makes it necessary to give additional consideration from a noise standpoint to machines equipped with bearings of the anti-friction types.

In one instance the holding-down bolts passed from the machine's frame through the insulating material to the building frame and made the insulating material practically useless. In other instances, the concrete floor has been poured in direct contact with the concrete base on its insulating cork, for the machine. As a result the effect of the cork blocks was nullified. In no case should the floor come in contact with the concrete block on which the machine is mounted.

Correct application of sound proofing or insulating material requires a knowledge of conditions surrounding the application. A machine mounted on an elastic mounting has a natural period of frequency of vibration. If the forced frequency of vibration of the disturbing noise approaches the natural frequency of the machine the noise will be magnified and conditions made worse rather than better by the treatment. Simply to place cork or some similar material under a machine will not necessarily be beneficial. The application of sound-proofing must follow sound engineering principles if success is to be assured.

If one of the patented materials manufactured for

Nature of Sounds on the Noise Scale

Noise Level, Decibels	Description of Noise	Noise Level, Decibels	Description of Noise
128	Threshold of painful sound	45	Average conversation
120	400-hp. airplane motor at 20 ft.	30	Residence in quiet district
100	Riveter on large steel beam 20 ft.	10	Rustle of leaves in gentle breeze
75	Applause in theatre	0	Zero on sound scale

this purpose is used, the service of the manufacturer should be secured and his recommendations carefully followed. Cork is one of the most widely used substances for this purpose. If cork is used, it should be purchased from one of the recognized companies, and their recommendations secured. A general specification for the use of cork is: It should be a light-colored variety, having a weight of approximately 1.25 lb. per board foot and about 2 in. thick. For motor-generator sets and control panels, this cork should be loaded to approximately 30 lb. per sq.in. Where torque is transmitted between machines on separate bases, the problem becomes more difficult, and the service of a competent engineer should be secured.

The ideal material for sound-insulation purposes is one having zero internal friction and therefore no damping. Any form of damping tends to transmit pressure and reduces the effectiveness of the insulating medium in proportion to the amount of damping. Where vibrations are present which have a period approaching the natural period of the machine on its mounting, damping will be found useful. This may be likened to applying a defect to correct a defect; obviously, the correct procedure is to change the mounting so that resonance cannot occur.

In order to solve the problem the frequencies producing the sound sensations must be known so that the insulation can be designed to prevent transmitting these frequencies. For machines that can be accurately balanced, frequencies in the audible range only need give concern. A given mounting to be effective and not detrimental should have a ratio of the impressed frequency to the natural frequency of the machine on its support of the order of 1.4 to 1. Where noise isolation is sought, this ratio should be increased 7 or 8 to 1.

Rubber has been found to be an ideal substance for isolating sound. Steel springs are also very effective for sound isolation but they must be correctly applied, but then this also may be said of any material used in the field of engineering. Rubber is never used pure and two specimens may vary widely depending upon their treatment and the materials compounded with them. For those desiring technical data on the application of sound-insulating substances, reference is made to a paper "Elastic Supports for Isolating Rotating Machines" by E. H. Hull and W. C. Stewart, A.I.E.E. Transactions, Vol. 50, 1931, and a paper "Influence of Damping in the Elastic Mounting of Vibrating Machine," by E. H. Hull, A.S.M.E. Transactions, Vol. 53, 1931.

It should be mentioned that the public is becoming noise conscious, and an understanding of noise control in buildings and in industry generally is becoming imperative for those responsible for the construction and installation of all types of machines.

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GASOLINE COOLS OUTDOOR PUMP MOTOR

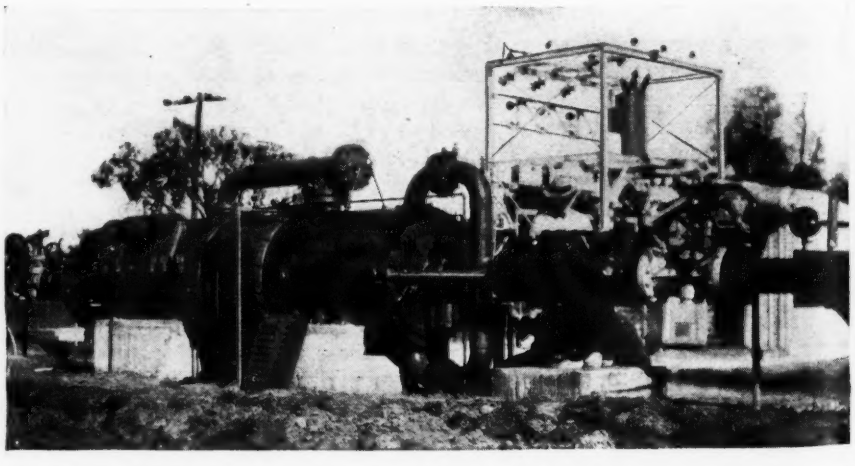
By H. W. STALNAKER
Engineer, Great Lakes Pipe Line Company

RECENTLY the Great Lakes Pipe Line Company, on its common carrier gasoline pipe line, put into operation gasoline-pumping station 5-A at Paradise, Mo. This outdoor station is the first of its type. The motor-driven pumping unit, built by Allis-Chalmers Company, was designed by D. J. Moran, president, and E. O. Bennett, chief engineer, of the Continental Oil Company. Patents covering the unit have been issued.

The 770-hp. motor driving the pump is totally enclosed and designed for 2,200 volt and 3,600 r.p.m. The stator frame is double walled, with a spiral passageway between, through which is circulated whatever quantity of gasoline happens to be passing through the pipe line, up to a maximum of 35,000 barrels per day.

The 8-stage pump is designed for 1,000 g.p.m. against a head of 2,520 ft. of gasoline and takes its suction from the spiral passage in the motor frame. High-pressure discharge is from the center of the pump, with a low-pressure stage on one end and an intermediate stage on the other. This relieves the stuffing boxes of high pressures and simplifies the packing problem. The design is such that the thrust is equalized, half of the impellers taking suction from one side and the others from the opposite side. In addition, a Kingsbury thrust bearing is incorporated.

A spacer section bolted between the motor and pump takes care of any deflection from external forces and acts also as a housing for the flexible coupling and mercoid contactors used in connection with the automatic operation of the unit. Lubrication of motor and pump bearings, all of which are of the sleeve type, is by oil rings and a pump which discharges a constant stream on each bearing. A 40-gal. oil reservoir is built into the bottom of the spacer section, and a heat exchanger built into the main fluid line between motor and pump serves to keep the lubricating oil at the desired temperature. Over-all efficiency of the pumping unit is slightly better than 80 per cent, which closely approaches that of the usual plunger-type pumps used in pipe-line service.



16-FT. BUTTERFLY VALVES CLOSE IN ONE MINUTE

By O. L. HOOPER

W. S. Barstow & Co., Reading, Pa.

AT THE Saluda plant of the Lexington Water Power Company, near Columbia, S. C., there are four 16-ft. motor-operated butterfly valves to shut off the water to the scroll cases of the turbines. The static head on the valves when the pond is full is 173 ft., or 75 lb. per sq.in. The position of the valves with respect to the turbine casing was fixed by the scroll-case entrance diameters, being 14 ft., and those of the penstocks and valves being 16 ft., so that a reducer section was needed that would give a gradual reduction in water-passage area. This reducer, 9 ft. long, caused the valve to be placed so far upstream from the turbine that it could be located outside the power house. This was economical to do because it allowed shortening the crane span and reduced the size of the superstructure.

Installing the valves outside the power house was a problem taken care of in the design of the substructure. A pit was provided inside the plant at each turbine where its valve could be erected with the crane, the bottom half of the valve housing being supported on rails embedded in concrete at the proper elevation. After the valve was assembled it was then slid along the rails to its position outside the power house.

Fig. 4 shows the seal arrangement on the valves. The seal ring is bronze, and the space between it and the casing is calked from the downstream side of the valve with lead wool. It will be noted that the valve is seated at an angle of 80 deg., with the longitudinal axis of the penstock and that its sides are machined to this angle.

Limit switches in the control circuit of the motor are an interesting part of the operating equipment. The switch that stops the mechanism when the valve has reached its open position is of the mercury type, supported on the yoke at the end of the crosshead guides outside the power house. As the valve opens, the crosshead moves upstream and pushes against a rod and compression spring extending through the yoke which actuates the switch. The spring resets the switch when the valve is closed.

The closed-position switch is shown in Fig. 3 and its location is at *S*, Fig. 1. As the valve closes, a setscrew moves the switch lever and trips the mercury switch. A maximum variation of $\frac{1}{16}$ in. in the position of the switch lever will trip the mercury switch. This distance corresponds to a variation of 0.015 in. in compression of the valve seat at the horizontal diameter and gives an indication of how accurately the valve can be seated. Wear on the seal rings is negligible and the valve leakage is practically constant. Tests show that the mechanism is capable of closing the valve in about one minute under full turbine discharge. Tests at 65 lb. pressure under regular operation caused a valve leakage of less than 0.4 second-feet.

A 24-in. motor-operated by-pass valve is used to fill the scroll case before the butterfly valve is opened. The switching equipment is so arranged that, by pressing the open button on the generator switchboard, the by-pass is opened, and when the scroll is filled a pressure switch starts the butterfly valve mechanism. In the closing cycle the two valves start to close together.

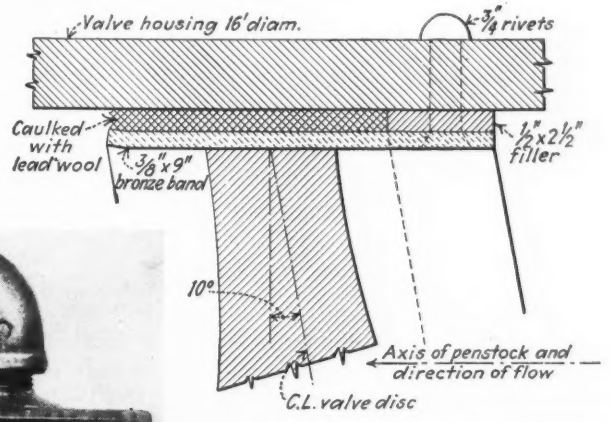


Fig. 4—Sealing arrangement for the butterfly valves

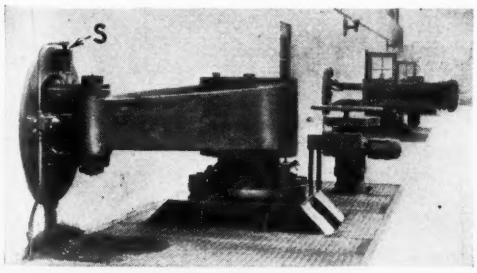


Fig. 1 (Upper left) — Upstream side of power house showing the nearest valve in closed position and the farthest open

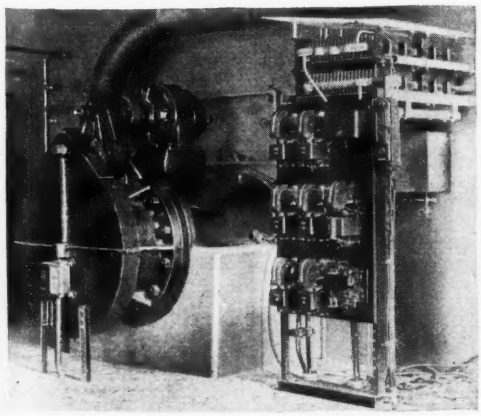


Fig. 2 (Lower left)—Motor-operated valve mechanism and control switchboard inside the power house

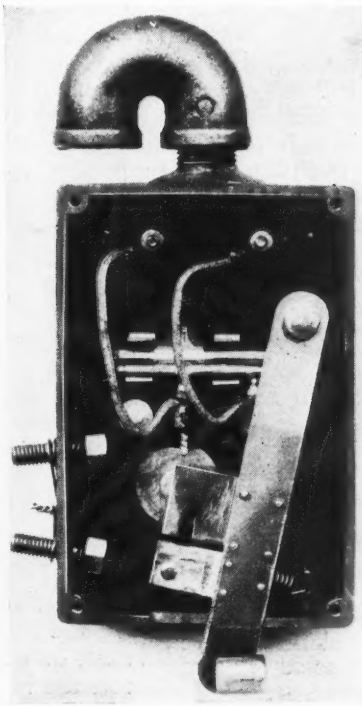


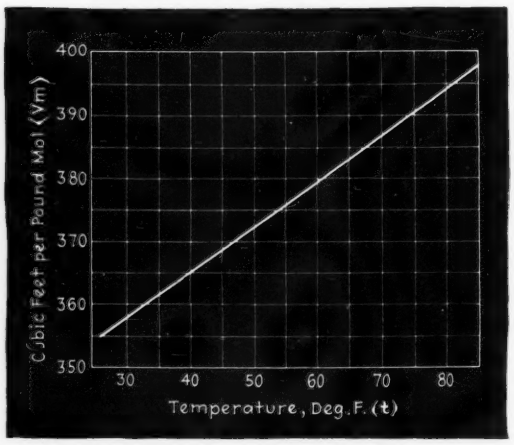
Fig. 3 (Left)—Mercury type limit switch for controlling closed position of the penstock valves

THE "MOL" SAVES YOUR TIME

A DIRECT ROAD TO THE ANSWER IN ALL COMBUSTION PROBLEMS

By E. F. DAWSON

Assistant Professor, School of Mechanical Engineering
University of Oklahoma



Cubic feet per pound mol of any gas at 14.7 lb. absolute pressure

CHEMICAL and process engineers everywhere are now using the "mol" in chemical computations. Most mechanical engineers, on the other hand, still compute combustion problems by the older and more tedious methods involving the use of tabulated gas densities. Much of this work is wasted effort. All power engineers should become familiar with the "molal" method of computation, both as a time saver and as a common language in which they can discuss combustion problems with chemical engineers.

In the English system the word "mol" is used to mean "pound mol." A "mol" of any substance (solid, liquid or gas) is then a quantity whose weight in pounds is expressed by the same number as the molecular weight. For example, the molecular weight of CO_2 is $12 + (2 \times 16) = 44$. One mol (pound mol) of carbon dioxide (CO_2) is, then, 44 lb. In the same way one mol of carbon monoxide (CO) is 28 lb., one mol of water (H_2O), 18 lb., one mol of oxygen (O_2), 32 lb. and one mol of nitrogen (N_2), 28 lb. One mol of carbon (C) is 12 lb. Likewise the carbon in one mol of either CO or CO_2 is one mol, or 12 lb.

The oxygen (O_2) in one mol of CO_2 is one mol, but the oxygen in one mol of CO is only one-half a mol.

Applied to a few simple combustion formulas the molal relations are as follows:

$2\,H_2 + O_2 = 2\,H_2O$	$C + O_2 = CO_2$
*2 Mol + 1 Mol = 2 Mol	*1 Mol + 1 Mol = 1 Mol
$2\,C + O_2 = 2\,CO$	$2\,CO + O_2 = 2\,CO_2$
*2 Mol + 1 Mol = 2 Mol	*2 Mol + 1 Mol = 2 Mol

If the word "Mol" is changed to "Volume" in all of the above equations they will give the relation between the volumes as far as the true gases are concerned (H_2, O_2, CO_2, O_2, and approximately for SO_2).

But remember that the Mol *is* a weight, rather than a volume. It *has* a volume depending on the pressure and temperature.

The volume relation indicated is based on the long known Avogadro's law—"At any given temperature and pressure equal volumes of all gases contain equal numbers of molecules." This simply means that the weight of this given volume will be directly proportional to the weight of one molecule of the particular gas.

Consider a volume of 379 cu.ft. of CO_2 at standard pressure and temperature (14.7 abs. and 60 deg. F.). It will weigh 44 lb. Under the same conditions 379 cu.ft. of O_2 will weigh 32 lb., of N_2, 28 lb. and of CO, 28 lb., because the total weights must be proportional to the molecular weights. *At a given temperature and pressure the volume of one mol (molal volume) is a constant for all gases.* This constant, as pointed out, is 379 cu.ft. for 14.7 lb. pressure and 60 deg. F.

The value 379 is obtained from the following general gas formula:

$$(1) \qquad \frac{PV}{WT} = \frac{10.72}{m}$$

where
P = Pressure, lb. per sq.in., abs.
V = Vol., cu.ft.
W = Weight, lb.
T = Temperature, deg. F., absolute
m = Molecular weight
10.72 = Constant for all true gases

This formula is worth remembering, because, without the use of tables, it will give the weight, volume, pressure, or temperature of any gas if the other three factors are known.

*This relation is true as the density changes.

If in this formula, V is taken as the volume of one mol (call it Vm) then W and m are equal, and the formula becomes:

$$(2) \qquad \frac{PVm}{T} = 10.72$$

or

$$(3) \qquad Vm = 10.72 \frac{T}{P}$$

This will give the mol volume of all gases at any temperature and pressure. The mol volume, in turn, can quickly be worked back into the weight per cubic foot or the volume of one pound.

$$(4) \qquad \text{Weight per cubic foot} = \frac{\text{Molecular weight}}{\text{Mol volume}}$$

$$(5) \qquad \text{Volume of one pound} = \frac{\text{Mol volume}}{\text{Molecular weight}}$$

The most striking examples of time saving by molal computations are found in problems involving gas fuel and flue gas simultaneously. The remainder of this article will be confined to applications in this field, particularly the determination of the heat losses of a gas-fired boiler.

The loses to be determined are: (1) the heat loss in the dry stack gases, (2) the heat loss due to evaporating and superheating the moisture formed from the combustion of the hydrogen in the fuel and (3) the heat loss due to incomplete combustion. The heat loss due to superheating the moisture in the air furnished for combustion is so small that it may be neglected or included with the radiation-and-unaccounted-for loss.

Dry Stack Gas Loss

The dry stock loss, L_d, in B.t.u., based on the combustion of one mol of fuel, can be expressed by the equation:

WHY THE "MOL"

1. Start off with the name. It's pronounced as in Dole.
2. *What is it?* A "mol" of any substance is a quantity whose weight in pounds is expressed by the same number as the molecular weight. E.G. one "mol" of CO_2 is 44 lb.; one mol of H_2O is 18 lb.
3. *What of it?* Chemical and process engineers everywhere save time by using the mol to juggle chemical formulas into useful answers.
4. *Should power engineers use it?* Some do; all should as the easiest method, particularly in combustion computations involving flue gases or gaseous fuels.
5. *Why is the mol so convenient?* Because molal quantities can be taken directly from the chemical formulas. Tables of gas density are unnecessary.
6. *What particular applications does this article cover?* Computations of heat losses in a gas-fired boiler.

$$(6) \qquad L_d = M_d S (T_s - T_r)$$

where

M_d = mols of dry stack gases per mol of fuel burned.
S = molecular specific heat of flue gas. (This value will vary slightly for different temperatures and different flue gas analyses, but a close approximate value may be taken as 7.10)
T_s = temperature of stack gases, deg. F.
T_r = temperature of the room or of the air supplied for combustion, deg. F.

The first item, M_d, is obtained by what is called a "carbon balance." Carbon in the flue gas comes from the carbon in the fuel. Hence, by knowing the analyses of the fuel and the flue gas, the mols of dry stack gases per mol of fuel is determined.

Carbon in the fuel burns either to carbon dioxide or carbon monoxide. Each of these constituents of the flue gas has one mol of carbon per mol of the constituent. The mols of carbon in the hydrocarbons in the fuel, per mol of the hydrocarbon, can be determined by noting the numerical subscript of the carbon in the chemical symbol of the hydrocarbon. Thus the mols of carbon per mol of the following gases are: methane (CH_4), 1; ethane (C_2H_6), 2; acetylene (C_2H_2), 2; ethylene, (C_2H_4), 2; carbon dioxide (CO_2), 1; carbon monoxide (CO), 1, etc.

Fuel Analysis:		Flue-gas Analysis:	
CH_4	77.6%	CO_2	10.0%
C_2H_6	18.7%	CO	0.3%
CO_2	1.2%	O_2	3.2%
O_2	0.2%	N_2	86.5% (by difference)
N_2	2.3%		
	100.0% (one mol of fuel)		100.0% (one mol of flue gas)

In the fuel there is one mol of carbon per mol of methane (CH_4), two mols of carbon per mol of ethane (C_2H_6) and one mol of carbon per mol of carbon dioxide. Therefore, the mols of carbon per mol of fuel is 1.162, figured as follows:

$$(1 \times 0.776) + (2 \times 0.187) + (1 \times 0.012) = 1.162 \text{ mols}$$

In the flue gas all of the carbon exists as CO_2 and CO. The analysis shows this to be 10.3 per cent of the flue gas. The mols of carbon per mol of flue gas is hence 0.103.

Since the carbon in the flue gas comes from the carbon in the fuel, the mols of dry flue gas per mol of fuel is:

$$(X) \qquad M_d = 1.162 \div 0.103 = 11.3 \text{ mols}$$

The B.t.u. loss of the dry stack gases per mol of fuel, L_d, may be converted into a percentage by dividing the value obtained in equation (6) by the heating value of one mol of fuel. The heating value of one mol of fuel can be obtained from the heating value per cubic foot and the number of cubic feet in the mol volume. If the pressure and temperature conditions are respectively 14.7 abs. and 60 deg. F., the mol volume is 379 cu.ft., as explained in the first part of this article.

The heat loss due to evaporating and superheating the water formed from the combustion of the hydrogen in the fuel can be represented by the equation:

$$(7) \qquad L_w = 18 M_w (1090.6 - T_r + 0.46 T_s)$$

where:

18 = Molecular weight of water vapor
L_w = B.t.u. heat loss per mol of fuel burned
M_w = Mols of water vapor in the flue gas formed from the combustion of the hydrogen in one mol of fuel.
T_r = Temperature of the room, deg. F.
T_s = Temperature of stack gases, deg. F.

The mols of water vapor formed per mol of fuel burned, M_w, is determined as follows: The mols of water vapor formed per mol of a hydrocarbon is obtained by dividing by two the numerical subscript of the hydrogen in the chemical symbol of the hydrocarbon. The mols of water vapor formed from the combustion of one mol of the following hydrocarbons are, then: methane (CH_4), 2; ethane (C_2H_6), 3; acetylene (C_2H_2), 1; ethylene (C_2H_4), 2, etc.

Example: Using the fuel analysis in the above example, the mols of water vapor formed per mol of the fuel burned are: $M_w = (2 \times 0.776) + (3 \times 0.187) = 2.11$ mols.

The heat loss, L_w, may be converted to a percentage value in a manner similar to that explained for the dry stack gas heat loss L_d.

Loss Due to Carbon Monoxide

Any carbon monoxide in the flue gas represents a heat loss. The heating value of carbon monoxide per mol is 121,900 B.t.u. as the molecular weight of carbon monoxide is 28. There are 28 lb. of carbon monoxide in a mol of carbon monoxide.

(8) $L_c = M_c \times 121{,}900$

where L_c = B.t.u. heat loss per mol of fuel burned

M_c = mols of carbon monoxide in the flue gas per mol of fuel burned.

Having the fuel and flue gas analyses, the mol of dry stack gases per mol of fuel can be determined as explained under "Dry Stack Gas Loss." This, together with the percentage of carbon monoxide in the flue gas, gives M_c.

Example: Using the fuel and flue gas analyses given above: There are 11.3 mols of dry flue gas per mol of fuel and 0.003 mols of CO per mol of dry flue gas. Therefore, the number of mols of carbon monoxide in the dry flue gas per mol of fuel burned is $M_c = 11.3 \times 0.003 = 0.034$ mols.

The heat loss in B.t.u. per mol of fuel burned L_c would then be 4,140 B.t.u. from equation (8). The percentage value of this item may be determined in a manner similar to that explained for the dry-gas heat loss.

Ratios

Mol *ratios* are volume ratios. Therefore, when analyzing the results of a test, any of the terms "mols," "cubic feet" and "volumes" may be used *in reference to ratios*. However, when not speaking of ratios, mols must not be confused with cubic feet.

The mols of dry flue gas per mol of fuel, as has been mentioned above, is obtained from the "carbon balance" of the fuel and flue gas analyses. From the example given above this was found to be 11.3 mols.

The number of mols of dry flue gas per mol of air supplied for combustion is obtained by a "nitrogen balance." The nitrogen in the flue gas comes from that in the air furnished for combustion. Air contains 79 per cent of nitrogen by volume. Since, then, the flue gas contains 86.5 per cent of nitrogen, by volume, the mols of dry flue gas per mol of air supplied for combustion is $79 \div 86.5 = 0.913$ mols.

It should be noted that this nitrogen balance can be used only for fuels low in nitrogen content.

In this problem there were found to be 11.3 mols of dry flue gas per mol of fuel. It follows that the mols of air supplied per mol of fuel burned are $11.3 \div 0.913 = 12.4$.

Summary of Combustion

For convenient reference the calculations already made will now be summarized and completed.

DATA

Fuel Analysis:		Flue Gas Analysis:	
CH_4	77.6%	CO_2	10.0%
C_2H_6	18.7%	CO	0.3%
CO_2	1.2%	O_2	3.2%
O_2	0.2%	N_2	86.5%
N_2	2.3%		

Heating value of the fuel at 14.7 lb. per sq.in. abs., 60 deg. F. and dry: 1,128 B.t.u. per cu.ft. Temperature of air supplied for combustion: 90 deg. F. Temperature of flue gas leaving boiler unit: 294 deg. F.

Calculations

Taking 14.7 lb. per sq.in. and 60 deg. F. as the pressure and temperature base conditions, the mol volume equals 379 cu.ft.

(5) $Vm = 10.72\ (60 + 460) \div 14.7 = 379$ cu.ft. per mol

Heating value of fuel per mol $= 1{,}128 \times 379 = 427{,}500$ B.t.u.

Dry fuel gas loss per mol of fuel burned $= L_d$

(6) $L_d = M_d\, S\, (T_s - T_r)$

$M_d = (CH_4 + 2C_2H_6 + CO_2)$ fuel $\div$ $(CO_2 + CO)$ flue gas

$= (0.776 + 2 \times 0.187 + 0.012) \div (0.100 + 0.003) = 11.3$

$L_d = 11.3 \times 7.10 \times (294 - 90) = 16{,}370$ B.t.u.

per cent loss $= (16{,}370 \times 100) \div 427{,}500 = 3.8\%$

Wet flue gas loss per mol of fuel burned $= L_w$

(7) $L_w = 18\, M_w\, (1090.6 - T_r + 0.46\, T_s)$

$M_w = 2CH_4 + 3C_2H_6 = (2 \times 0.776) + (3 \times 0.187) = 2.11$

$L_w = 18 \times 2.11\ (1090.6 - 90 + 0.46 \times 294) = 43{,}150$ B.t.u.

per cent loss $= (43{,}150 \times 100) \div 427{,}500 = 10.1\%$

Loss due to carbon monoxide $= L_c$

$L_c = M_c \times 121{,}900$

$M_c = (CO) \times$ [formula (X)]

$M_c = 0.003 \times 11.3 = 0.034$

$L_c = 0.034 \times 121{,}900 = 4{,}140$ B.t.u.

Per cent loss $= (4140 \times 100) \div 427{,}500 = 1.0\%$

Air, Fuel and Flue Gas Ratios

The volume ratio of the flue gas and fuel is evident from equation (X). For the example given above this indicates that 11.3 volumes of flue gas are formed by the combustion of one volume of fuel.

The volumes of dry flue gas per one volume of air supplied for combustion is obtained by dividing 79, the volume percentage of nitrogen in air, by 86.5, the volume percentage of the nitrogen in the flue gas analysis. This value is 0.913.

The volumes of air supplied for combustion per one volume of fuel burned, obtained from the above two ratios, is 11.3 divided by 0.913 = 12.4.

▼ ▼ ▼

Power Bibliographies

A London correspondent reports that at the recent meeting of the International Executive Council of the World Power Conference a Sub-Committee was appointed to the task of consolidating into one single international publication the various power bibliographies which up to the present have been separately issued by the English, German, Polish and South African Committees of the World Power Conference.

It was decided to postpone a regular monthly or quarterly World Power Conference bulletin, suggested publication of which has been discussed off and on for several years.

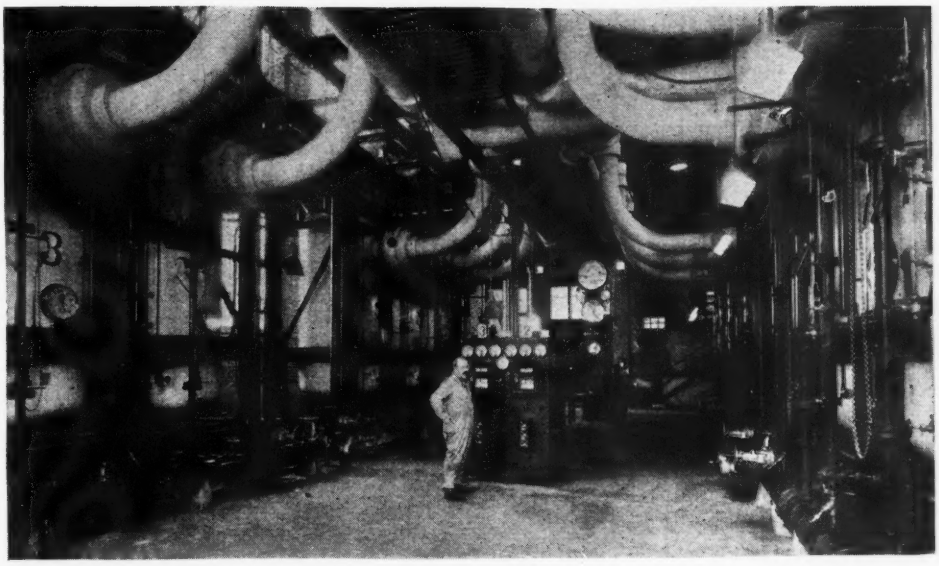


Fig. 1—Largest electric steam generator installation has a normal capacity of 147,000 kilowatts

ELECTRIC STEAM GENERATORS

USE EXCESS HYDRO POWER

Where large blocks of low-cost hydro power are available, electric steam generators offer interesting possibilities to engineers in industrial and utility plants. Several ways of using hydro excess are here suggested

IN CANADA where fuel costs are generally comparatively high and large quantities of cheap hydro power are available, electric steam generators have been used extensively. Conditions under which water power is developed and used in the United States have not been so favorable for electric steam generation and such installations are neither so large nor numerous as in Canada. However, the present prolonged business depression has seriously curtailed the load on some of the power systems supplied by hydro in the United States. A study of the possibilities of converting this excess power into steam may show it to be an economic source of revenue.

Steam cannot be produced by electric steam generators from power sold on the usual kilowatt-hour rates, in competition with coal. There are, however, several conditions under which electric boilers are being used economically.

Large blocks of hydro-electric power, for which there is not an immediate market may be used to supply the total steam requirements of a large industrial plant, thus delaying investment in a fuel-fired boiler plant. Under these conditions the power is worth the price of steam in a fuel-fired plant minus the overhead and operating costs of the electric-steam-generator plant. The initial and the operating costs of an electric-steam-generator plant are low compared to a fuel-burning plant. The difference in fixed and operating costs and the cost of fuel is what can economically be paid for power supplied to the electric boilers. This amounts to a power rate approaching that paid for large blocks of power sold at large hydro plants. With such a market assured for their surplus power, large hydro projects can be made that otherwise would be uneconomical. The whole project can be completed as a unit, consequently with a minimum investment.

As the industrial market develops for the power, that going into steam may be diverted to the new market and a fuel-burning boiler plant built to supply the steam load. The electric steam generators may then act as reserve capacity for the fuel-burning plant and reduce the investment in it by that amount. The electric boiler plant is also available to absorb any surplus power that may be available, such as at night and over week-ends.

Electric steam generators have been used to advantage where power is purchased in an industrial plant on a horsepower-year basis. Excess power above the industrial load demand, up to the limit of the contract is used in an electric boiler. The only cost for this steam is the overhead on the electric-steam generating plant and its operating cost, which are both low. If there is considerable excess power, the electric steam boiler will prove to be a profitable investment.

Electric boilers are also used to absorb excess power from hydro plants. To do this generally requires industrial plants within a short transmission distance of the hydro-electric stations that are large users of steam. The electric boilers are installed in these plants, operated in parallel with fuel-burning boilers, and the steam sold on a basis of coal cost saved.

The excess power may be produced in a number of

ways. During flood-water periods the hydro plants can be loaded to their full capacity and the excess above the normal load turned into the electric steam generators. During nights and over week-ends when there is an excess of water, instead of running to waste it can be taken through the hydro plants and the power used to generate steam.

On rivers where the regulating reservoirs are long distances from the power plants, it is practically impossible to control the flow so that no water will spill at the plants and at the same time be sure that sufficient water will be available. About the best that can be done is to allow a certain excess of water to flow from storage. The excess can be taken through the wheels and the power used in electric steam generators. This generally can be done by loading the reserve capacity that must be kept in service. By doing this the over-all efficiency of the plant is improved and the kilowatt-hour output for the available water increased. Although the rate is low at which the excess power going to the steam generators is sold, the power costs practically nothing to produce, and any income obtained from it is largely clear gain.

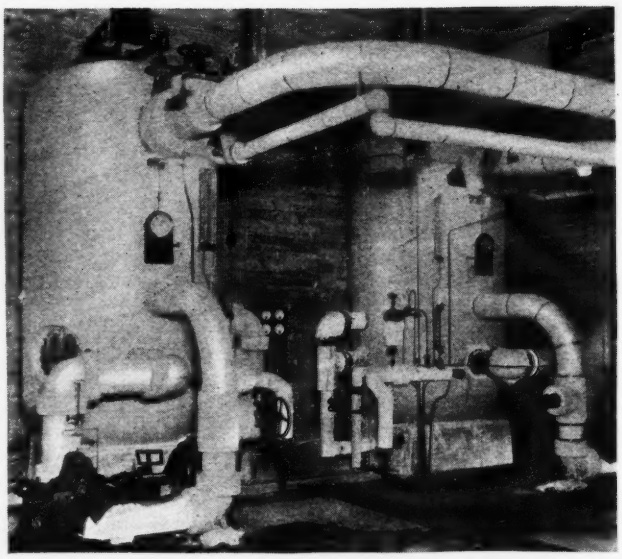
During periods of business depression, as at present, electric steam generators may be used to convert excess power, made available because of loss of industrial load, into steam. Several such installations have been made by power companies in Canada during the last two years. Even though the power has to be sold at a rate to compete with fuel, the comparatively low cost of the electric boilers makes possible turning excess power into revenue.

Up to the beginning of this year medium- and large-size electric steam generators had been installed in Canada with an aggregate capacity of 1,100,000 kw. The largest installation has a normal capacity of 147,000 kw., with three units of 42,000 kw. each and one of 21,000 kw. Until about two years ago this installation supplied all the steam for a 600-ton pulp and paper mill. These boilers now operate in parallel with a coal-fired boiler plant and use excess power from a large hydro system. Another installation of 64,000-kw. rating now supplies all the steam for a 250-ton paper mill.

All medium- and large-capacity electric steam generators operate on alternating current, usually at 550 to 13,200 volts. An exception to this is a 16,000-kw. unit installed in the United States for 22,000-volt operation. Electric boilers are in operation for steam pressures up to 250-lb. gage.

A very large percentage of the electric steam-boiler capacity in operation in Canada and the United States is of the electrode type. With this design the electrodes are immersed in the water and steam is produced by current flowing between them. There are two general designs of this type: one the Kaelin, built by the Dominion Engineering Works, a section being shown in Fig. 6. This design shows three electrodes in a single tank. In some of the large-capacity designs three separate tanks are used with a single electrode in each tank. In Fig. 6 current flows from electrode to electrode and from the electrodes to the neutral plate. The latter is to protect the boiler shell against any action from the current.

Feedwater enters the boiler through the pipe at its bottom. Projecting the feedwater into the center of the electrode nest causes a circulation in the boiler, maintains



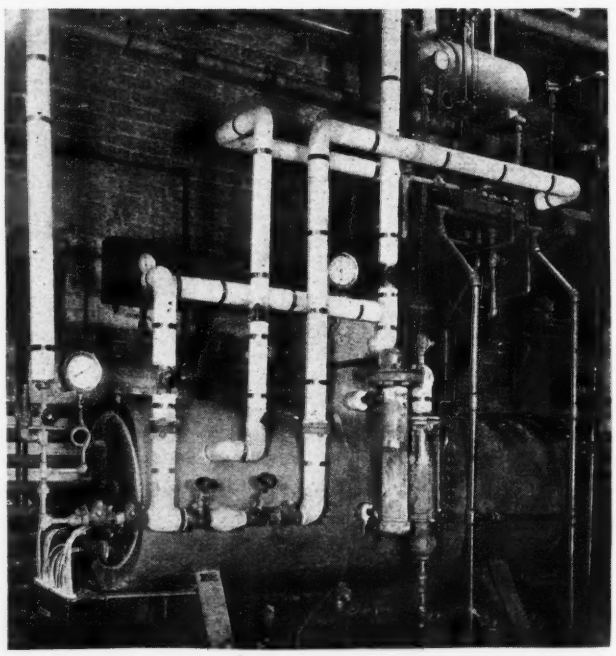


Fig. 2 (Top)—Two 10,000-kw. forced circulation-type electric steam boiler in a paper mill. Fig. 3—A 120-kw. full-automatic electric steam generator supplying process steam where the atmosphere might become explosive

a fairly uniform temperature in it and keeps the electrodes clear of steam bubbles.

The other electrode-type boiler, Fig. 5, is that developed by the General Electric Company and now built in the United States by the Bigelow Company. This boiler is divided into two parts: In the upper part the steam is generated in the same way as in the previously described type. The bottom part of the boiler acts as a hotwell, and water is circulated between it and the upper part by a circulating pump. Water is allowed to drain from the upper chamber, called the basket, to the hotwell, where it mixes with the incoming feedwater. The water level in the basket depends upon the rate of inflow compared to the rate of drainage.

Rate of steam generation in the two types is controlled by the length of electrode immersed and the amount of concentrate in the water. As neither of these lend themselves readily to quick changes, electric boilers

are not adapted to supplying rapidly changing demands. When they are operated in parallel with fuel-fired boilers, as they frequently are, the latter carries the load swings and the electric boiler operates on a fairly constant load. Where electric steam generators have been installed to supply all the load demands, accumulators are generally provided to take the load swings.

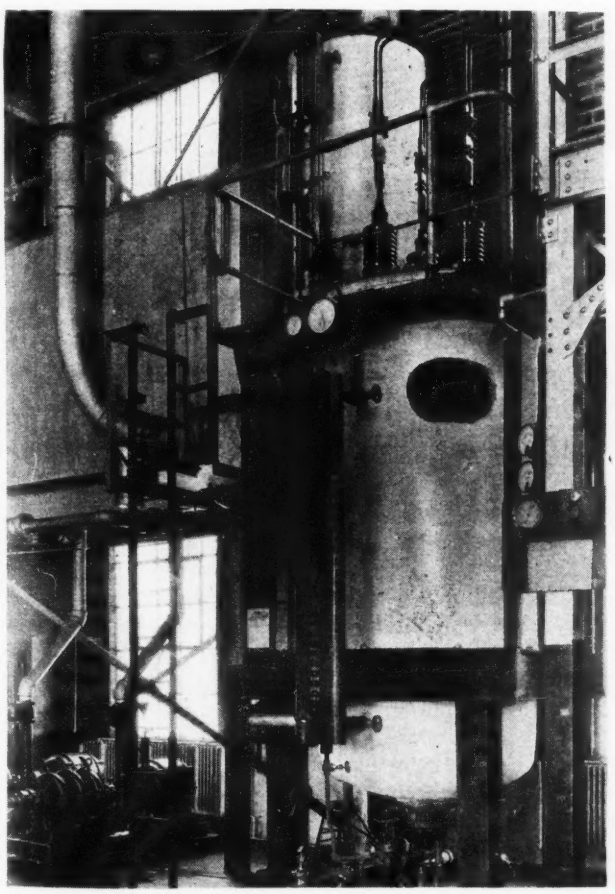
Fig. 4 shows an electric steam boiler with an auxiliary tank installed above it in which feedwater at steaming temperature is stored in off-peak periods for use during the peak loads. When demands for steam increase, hot water is allowed to flow from the auxiliary tank and the level on the electrodes is raised quickly to meet the steam requirements. When the demand decreases, the water level is reduced in the boiler by forcing part of the water up into the auxiliary tank for future use. This installation was described in *Power,* April 26, 1932, page 624, by M. G. Saunders, Mechanical Superintendent, Aluminum Company of Canada, Limited, and is an example of one method of adapting electric boilers to varying loads.

Electric steam generators of the type in Fig. 5 are usually automatically controlled; where most of type Fig. 6 are manually regulated. Automatic control has been developed for this type, one design being described in *Power,* Sept. 29, 1931, page 458, by Milton Eaton, Electrical Engineer, Shawinigan Chemicals Company.

Small electric boilers are used to supply steam for heating buildings and to a wide variety of heating and cooking applications in industrial processes. Most of these boilers are of the immersion type, in which resistor heating units are immersed directly in the water. Resistor heater units are also used indirectly by putting them inside the tubes of fire-tube boilers.

The efficiency of electric steam boilers is high if the feedwater is of good quality. Where there is a high percentage of impurities in the feedwater, the efficiency will be adversely affected because of increased bleeding necessary to keep down the concentrate in the boiler. In a report presented at the 1931 annual convention of the Canadian Electric Association data were given on 22 electric steam generator installations. The operating efficiencies of 18 of these were given and ranged from 90 to 98.5 per cent. Twelve of them operated at an efficiency of 95 per cent or higher. A 500-kw. installation had an efficiency of 98 per cent, making it evident that size has little influence on efficiency.

Fig. 4—An 8,000-kw. manually controlled electric steam boiler that supplies peak loads



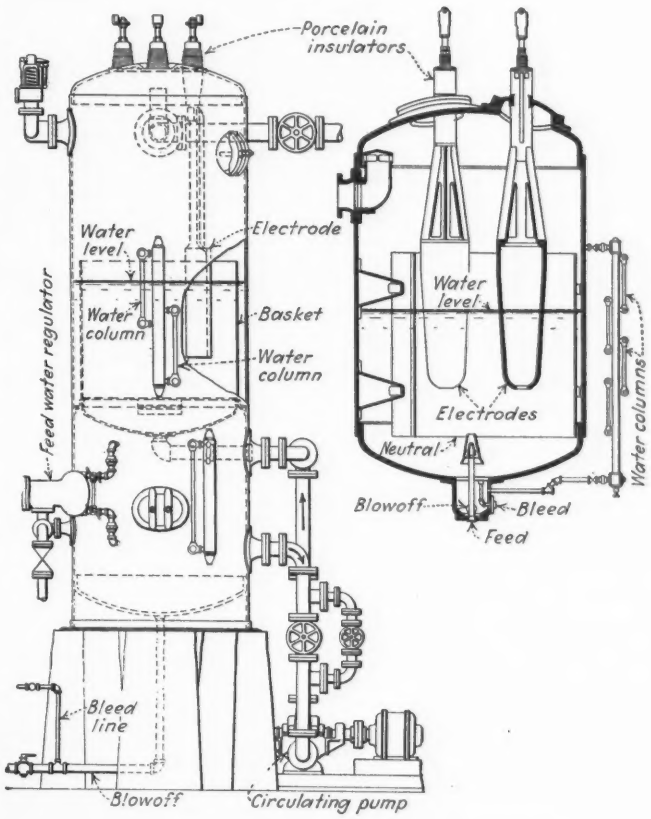
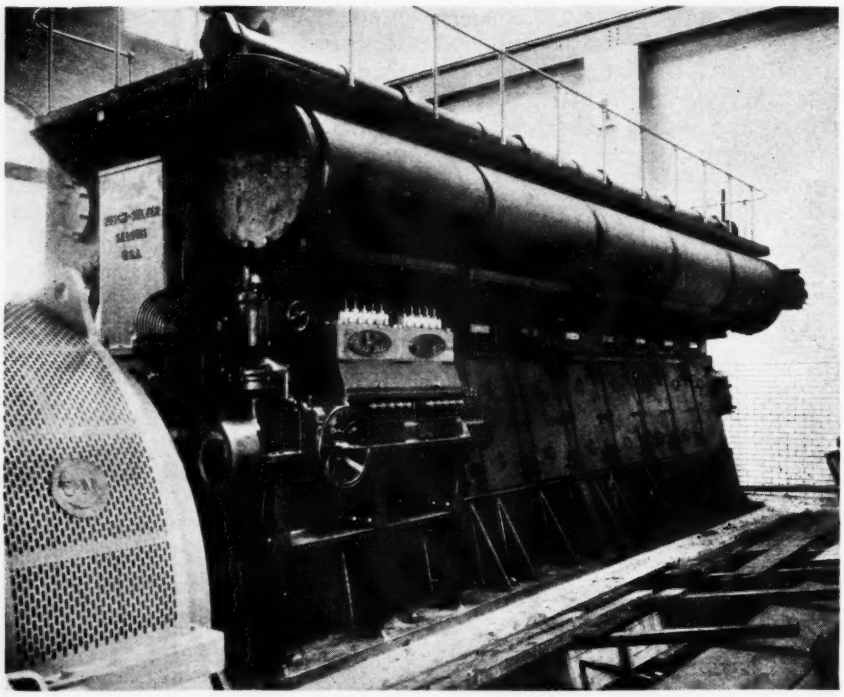


Fig. 5 (Left)—Three-phase forced-circulation type electric steam generator. Fig. 6 (Above)—Three-phase Kaelin-type electric steam generator

▼ ▼

Structural Metals Data

A POUND of magnesium makes a 2½-inch cube or a ½-inch square bar 64 inches long. A pound of steel makes a 1½-inch cube or a ½-inch square bar 14 inches long. A pound of aluminum makes a ½-inch bar 42 inches long. In 1915, a pound of ingot magnesium cost $5.00, today 30 cents. A pound of ingot steel costs 2 cents. Per pound magnesium bars cost fifteen times as much as steel; per cubic inch, only three and one-half times as much.



The new diesel being mounted at Morgan Street

POWER BILL LOWERED $60,000

OIL, STEAM AND PURCHASED POWER COMBINED FOR ECONOMY

By EDWARD E. ASHLEY
Consulting Engineer

Because power users are always on the watch for ideas on how to cut power costs, Mr. Ashley has been induced to tell his experience in combining an oil engine with an existing steam plant which also purchases some power, at Union Stock Yards, Chicago

▼

WHAT yesterday seemed inconsequential economies in production or operating costs may today be the means of maintaining a black-ink balance sheet. Every possible way of making savings by reducing cost of operation must be thoroughly investigated. As a case in point, I was asked to investigate and recommend possible economies of power plant operation at the Pau Corporation, Chicago, Ill. This corporation distributes light, power and heat to various buildings in and about the Union Stock Yards and Central Manufacturing District of Chicago.

While the corporation has several plants, the one investigated was that at Morgan Street. It distributes about 54,000,000 kw. in electric energy annually for light and power and about 100,000,000 lb. of steam for heating purposes.

Built about 1907 by Sargent & Lundy, it had at that time one Allis-Chalmers engine driving a 1,000-kw. Crocker-Wheeler 2,300-volt, three-phase generator, an air compressor and a few pumps for the water system of the yards. As additional electric energy was required, the plant was enlarged and service from the Commonwealth Edison Co. added, until the capacity of the plant reached about 6,000 kw. with a corresponding capacity furnished by the Edison company.

This arrangement was satisfactory as long as the plant was able to take all the peaks in the load and the demand on the utility lines was kept more or less uniform. However, as load requirements continued to increase, it was impossible to proportion them successfully between plant and utility. The service became considerably unbalanced, and at the time of investigation the plant was generating about 30 per cent of its electric energy requirements and the Edison company furnishing 70 per cent.

Of the 30 per cent generated, about 10 per cent was a by-product of the steam required for heating. This arrangement made it necessary for the utility to carry most of the peak load, with a resulting load factor of

about 70 per cent and a rather high unit cost for the total energy, produced and distributed. One of the contributing reasons for this unbalance was the failure to increase plant capacity in proportion to the growth of load. Particularly was this so in connection with the boiler plant.

Several studies were made, including the possibilities of abandoning the present plant and rebuilding or reducing the capacity of plant and buying all electric energy beyond that produced as a by-product of the heating steam. The scheme finally adopted was that of making carefully planned improvements within the plant and installing one or more diesel engines.

Building a new plant in place of the present one was abandoned because of the limited amount of condenser water available and because expansion of the distribution system would make a plant further to the west much more desirable. Moreover, there was uncertainty, at this time, of obtaining sufficient additional load to show the economies that would warrant the large capital expenditure necessary for such a plant.

The purchase of the additional energy was not attractive because to do this, it would have been necessary to increase demand requirements. Actually purchased power, on this basis, showed an increase in unit cost over that being charged at the time.

Further study disclosed that if it were possible to increase the load factor on the Edison service from 70 to 90 per cent, by cutting down the maximum demand from 6,000 kw. to 4,000, a saving in the average unit rate of 0.5 mills per kw.-hr. could be expected. This would require an increase in the generating capacity of the plant from 6,000 kw. to 8,000 kw. under present conditions and to 10,000 kw. to take care of immediate future requirements. With this plan, as the load increases, the demand on the utility service may be increased to 6,000 kw. and still maintain the same load factor and balance between plant and utility service.

The plant, as now operating, consists of four turbo-generators—one 6,000-kw., one 3,200-kw., one 3,000-kw. and one 2,500-kw. These are all bleeder type and operate with steam at 200 lb. and 175 deg. superheat, delivered from a battery of six 5050-sq.ft. and two 3500-sq.ft. B. & W. boilers with underfeed stokers. These boilers are operated, under normal conditions, at about 150 per cent of rating, and during peak periods generate 240,000 lb. of steam. This, however, is not possible without objectionable smoke. Under normal operation the evaporation is at the rate of 7 lb. of water per pound of 11,250-B.t.u. coal. The annual consumption of coal is about 41,000 tons.

By the studies made, it was found that if the output of the boilers could be increased, there was plenty of electrical generating capacity to carry continuously about 6,000 kw., leaving 2,000 kw. to be taken care of by additional equipment.

By slightly changing the masonry of the boilers and taking advantage of the large ashpits, it was possible to install powdered fuel equipment. This gave the boilers the additional capacity required and at the same time made it possible to use the cheaper grades of coal available within a short distance of Chicago. The furnaces were redesigned for a normal continuous rating of 225 per cent. This limit was set for two reasons, one of them that, considering the age and size of boiler units, the use of water walls would not be economical, the second that this rating seemed from careful observation of a comparable installation in operation, to be the most efficient and practical with the 1,900-deg. fuse point fuel to be used. If trouble were to be avoided, it was decided that a heat liberation of 14,000 B.t.u. and 13 per cent of CO_2 would be the maximum for successful operation. The furnaces were designed accordingly, and they have about 4,000 cu.ft. of volume and 200 sq.ft. of exposed boiler surface above.

Some of the economies expected from steam plant changes alone are: saving of one dollar per ton of coal, about 16 per cent increased efficiency, a saving in banking of fires at night and in ash handling and a decrease in the cost of maintenance.

Coming now to the diesel engine, it did not, at this time, seem practical or economical to consider the installation of any more steam-driven generating units to supply the additional energy needed to carry out the above plan. Not only was the amount of condenser water limited but of such a poor quality as to prohibit its use except with jet condensers. Also there was the fact that such steam-driven units would require additional boilers. This would have meant a tremendous change to the entire plant, if any reduction in cost of producing electric energy were to be accomplished.

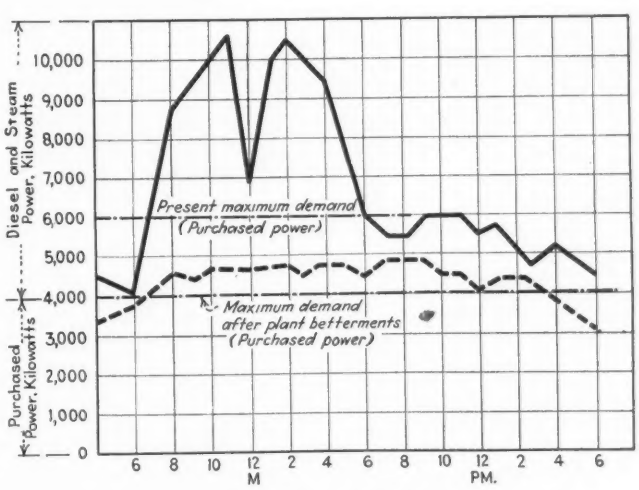
By the installation of diesel equipment, the investment would not only be less but be extremely economical in cost of producing the electric energy. Such a unit would also fit into any expansion program or future development either as a standby or as part of an entirely dieselized plant.

Under present operating conditions the cost of the electric energy on the transmission lines of the corporation is 6.8 mills for purchased energy and 11.0 mills for generated energy. The latter figure does *not* credit power with the value of the by-product steam used for heating and which has not been taken into consideration, since betterments made were for the sole purpose of reducing the total cost of power, thereby lowering general production cost.

The estimated cost of making the betterments was $250,000, and the depreciation charge distributed over energy utilized was 0.5 mills per kw.-hr.

The cost of electric energy after betterments and redistribution of loads will be: purchased energy 6.3 mills, steam-generated energy, 8.0 mills, diesel-generated energy, 3.5 mills.

At the present time the annual cost of electric energy is distributed thus:



Daily curves, showing relation of purchased and made power to peaks before and after betterments

Purchased, 42,000,000 kw. @ 6.8	$285,600
Generated, 12,000,000 kw. @ 11	132,000
	$417,600

after betterments and rebalancing of load it is expected that the cost of energy distributed will be:

Purchased, 33,500,000 kw. @ 6.3	$211,050
Generated by steam, 10,500,000 kw. @ 8.0	84,000
Generated by diesel, 10,000,000 kw. @ 3.8	38,000
	$333,050
Depreciation charges	25,000
	$358,050
Difference or Saving	59,550

This does not take into consideration that without any additional changes the plant may produce an additional 10,000,000 kw.-hr. when required.

Nor has consideration been given to the savings which may be effected by the utilization of the waste heat in the exhaust gases and heat in the cooling water of the diesel engine. The following table gives the heat distribution of a diesel engine.

Useful work	32.8%
Cooling water	30.9%
Exhaust gas	32.3%
Radiation, etc.	4.0%
	100%

The cooling water will be taken from one of the mains of the yard's flushing system at about 60 deg. F.; it will pass through the water jackets and coolers and discharge into a waste-heat boiler at about 140 deg. F., thence either to feedwater heater at about 180 deg. F. or to return through an automatic bypass into the yard's flushing system reservoir. It is expected that by this system no water will be wasted and there will be a recovery of about 9,000,000 B.t.u. hr. or an equivalent of 1,065 lb. of coal per hr. resulting in an additional saving of $7,600 per year.

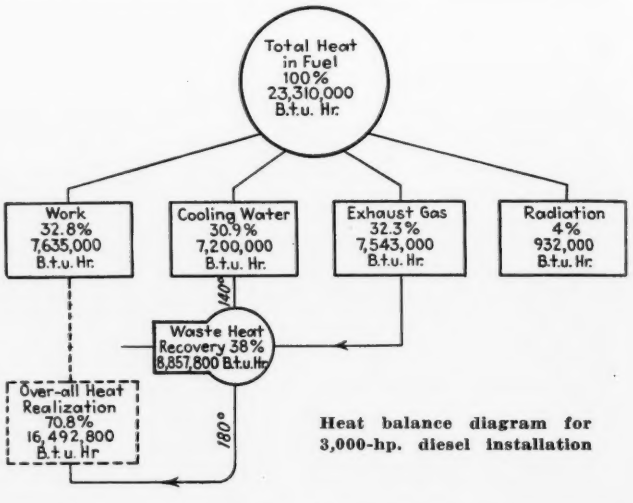
For the present, one of the old boilers will be used for waste heat recovery. Engine will exhaust directly into boiler, with bypass connection so that the gases may enter the boiler, or discharge directly to atmosphere through a duplex cast-iron muffler. In the engine specifications it was particularly stressed that the engine and generator should have over-all dimensions permitting them to be installed within the present generating room of the power house. The available space was formerly occupied by a large air compressor and is between two turbo-generators. Also, it is required that the engine must operate in parallel with not only the steam-driven turbo units, but with the Commonwealth Edison service as well: also that the net output must be not less than 2,000 kw.

To illustrate the simplicity of the engine selected; during shop test, the engine was stopped and piston removed from one of the cylinders in 12 min.; it was then completely dismantled in 16 min. more. It was inspected, including the pin bearing, in 14 min. and again assembled and installed in 48 min. and engine put back into service in an elapsed time of 90 min.

The question of engine type was determined after a thorough and careful investigation of not only the American practice but also the practice in Europe. It was decided to use the airless injection and trunk piston type, due to their simplicity, reduction of moving parts and ready accessibility in case of repairs. It is not the intention to add any labor within the plant for the operation of the oil engine.

The engine selected is a 10-cyl. two-cycle, single-acting unit with airless fuel injection by the Hesselman system, with a guaranteed net output of 2,100 kw. and a fuel economy of 0.42 lb. per b.hp.

Due to the space limitation, it was necessary to make some modification in the standard arrangement of lubrication pump and type of generator, the latter being of the


Total Heat in Fuel 100% 23,310,000 B.t.u. Hr.
Work 32.8% 7,635,000 B.t.u. Hr.
Cooling Water 30.9% 7,200,000 B.t.u. Hr.
Exhaust Gas 32.3% 7,543,000 B.t.u. Hr.
Radiation 4% 932,000 B.t.u. Hr.
140°
Waste Heat Recovery 38% 8,857,800 B.t.u. Hr.
Over-all Heat Realization 70.8% 16,492,800 B.t.u. Hr.
180°

Heat balance diagram for 3,000-hp. diesel installation

flywheel type with an exceptionally low WR^2 to avoid critical operating conditions. Flywheel effect for speed regulation was not necessary.

The generator is designed for 12,000-volt, 60-cycle, 3-phase operation. There are 30 poles, without damper windings but with solid polepieces and solid pole shoes. Rotor is designed with proper regard to flywheel effect. The exciter is placed to one side of generator and is belt driven. This was necessary because of clearances required for traveling crane.

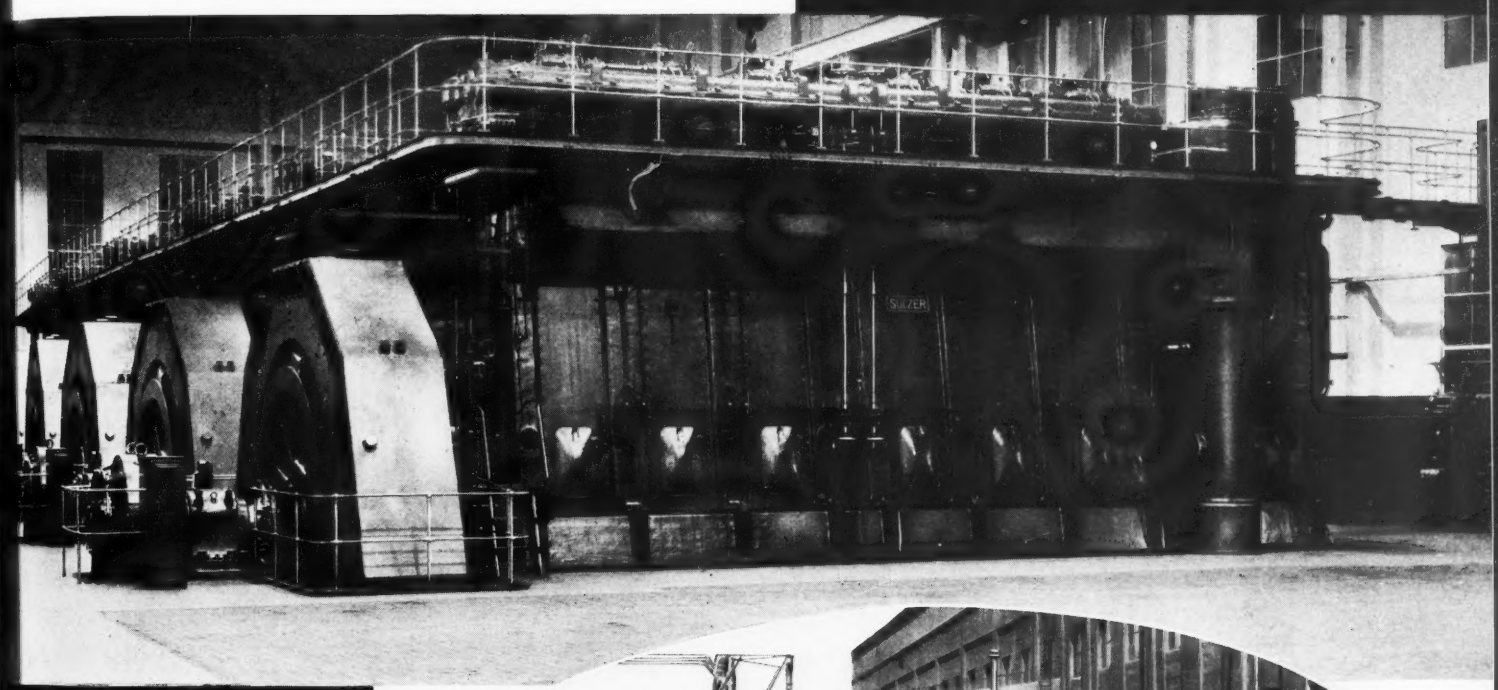
The scavenger blower is of the centrifugal type, driven by a 2,300-volt induction motor with pushbutton control operated from the engine starting station, and alarm signals so that a signal is immediately rung should there be a failure of the blower for any reason.

The air for scavenging is taken from outdoors, through a multiple filter arranged with a bypass so that in winter a certain percentage of air may be taken from the generator room to temper the air as finally delivered to the engine. An unusually large fuel oil storage capacity is provided in two 100,000-gal. tanks about 200 ft. away from the plant but adjacent to the unloading trucks. This will make it possible to take advantage of favorable oil prices.

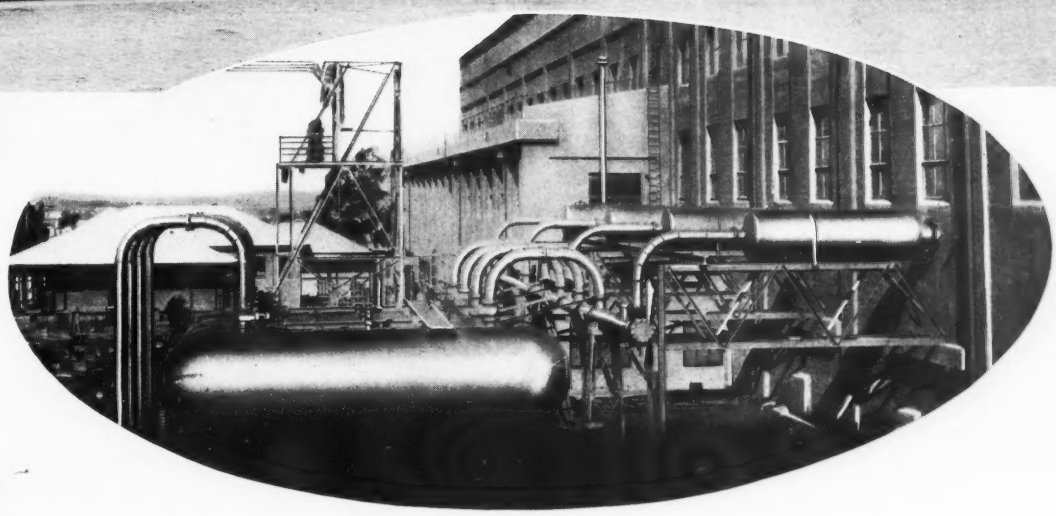
Every provision is being made to protect the fuel oil and make it usable under all conditions. Heaters and centrifuges are provided as it is expected that material savings will be effected by proper care in removing all possible dirt and grit before the oil enters the engine. This allows the use of cheaper grade oils than those usually used.

The writer wishes to acknowledge at this time the cooperation and assistance of Edward Bull, manager of the Pau Corp., and to Roy Cooper, engineering assistant to Pres. A. G. Leonard, who were directly responsible for the supervision and installation of the equipment.

DIESELS • BELOW CAPRICORN



A 30-pole, flywheel-type generator supplying current is direct-coupled to each diesel



Air receivers are mounted compactly outside the plant building, which is 70 ft. high

BROKEN HILLS, New South Wales, has just completed a diesel-driven central station, 366x96 ft., expected to provide 50,000,000 kw.-hr. per year • In the station are six Sulzer, 2-stroke, 6-cyl., 160-r.p.m., 3,000-b.hp. diesels, each direct-coupled to a 6,900-volt, 2,500-kva., British-Thomson-Houston a.c. generator • There are also four Mirrlees, Bickerton & Day 4-stroke, 8-cyl., 214-r.p.m., 1,200-b.hp. diesels, each direct-coupled to a compressor supplying air at 95 lb.

TIDE WATER *Tests* 12

PROVES TYCOL FIRST IN

INDUSTRIAL TYCOL OILS-GREASES

TIDE WATER

■ *In the Tide Water laboratory, 15 control tests guard Tycol quality. The illustration shows how the stop watch is used to determine viscosity to the fraction of a second.*

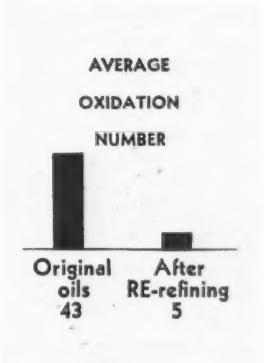
KNOW YOUR OILS

So sure is Tide Water of Tycol superiority, that it is making an unprecedented offer to buyers of turbine and Diesel oils. Tide Water will be glad to *re-refine for you,* by its Edeleanu Process, a sample of the turbine and Diesel lubricating oils you are now using. Not only that, Tide Water will welcome the presence of your own technologists, at the time.

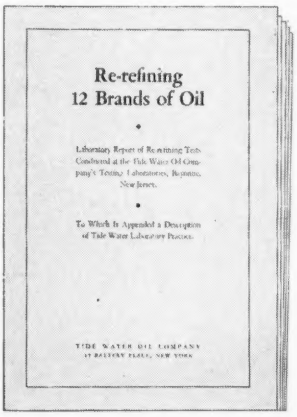
Competitive Oils by RE-*refining*

LUBRICATING VALUE

This Laboratory Report gives complete test-data and explains facts important to every user of turbine and Diesel oils.



When you buy turbine and Diesel oils, you are buying lubricating performance. You have every right to expect stability, long-life, minimum acidity, absence of sludging tendency.



Naturally, you can't get these properties in oils containing from 9.8% to 25.3% (by volume) of impure extract. You can't get them in oils with oxidation numbers ranging all the way up to 194!

You would say that such oils are not being offered. But Tide Water bought in the open market 12 leading brands of oils, and gave them the *re*-refining test. That is, Tide Water *re*-refined them by the Special Edeleanu Process used to refine Tycol Turbine and Diesel Oils.

And the findings are exactly as stated above. An average of 16% impure extracts was re-refined out of these oils! The average oxidation number was lowered from 43 to 5!

PROPER REFINING THE KEYNOTE

The Laboratory Report goes into detail about all this. And it proves conclusively that PROPER refining is the keynote of good oil . . . that Tide Water's Special Edeleanu Process produces an oil of maximum stability and lubricating value.

Briefly, the reasons are: The Process is a physical solvent treatment. It dissolves ALL unstable hydrocarbons, found even in the best of crudes. It starts NO chemical reaction upon the components of oil, stable or unstable. It forms NO new unstable substances. And it preserves the pure and stable hydrocarbons of highest lubricating value.

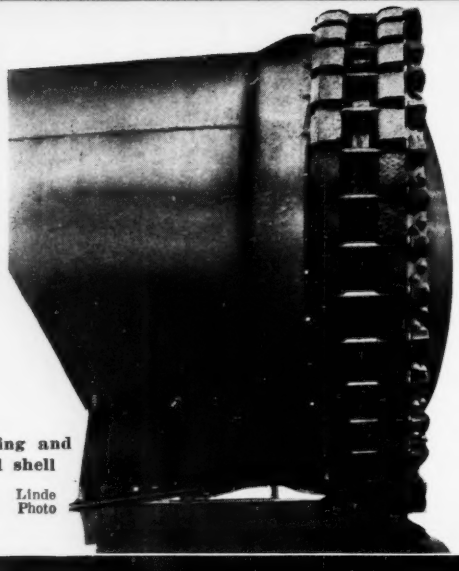
That is why Tycol Turbine and Diesel Oils, being 100% paraffine base, and refined by this Process, have purity and stability which no other oils possess. Tycol Oils have oxidation numbers ranging from 1/4 to 1/50 of those of competitive grades.

BE GUIDED BY SERVICE RECORDS

In the final analysis, it is service that counts. Everything shown in these laboratory tests is borne out by experience. Tycol oils have set up new records of performance for some of the country's leading producers of power.

Based on these records, you can depend on Tycol oils for low acidity, low carbon deposition and better demulsibility. You can depend on them for stability, for non-sludging, long-lasting, efficient, economical lubrication!

If you are interested in lubricating efficiency, by all means send for the Laboratory Report, "Re-refining 12 Brands of Oil." Address Tide Water Oil Sales Corporation, 17 Battery Place, New York.



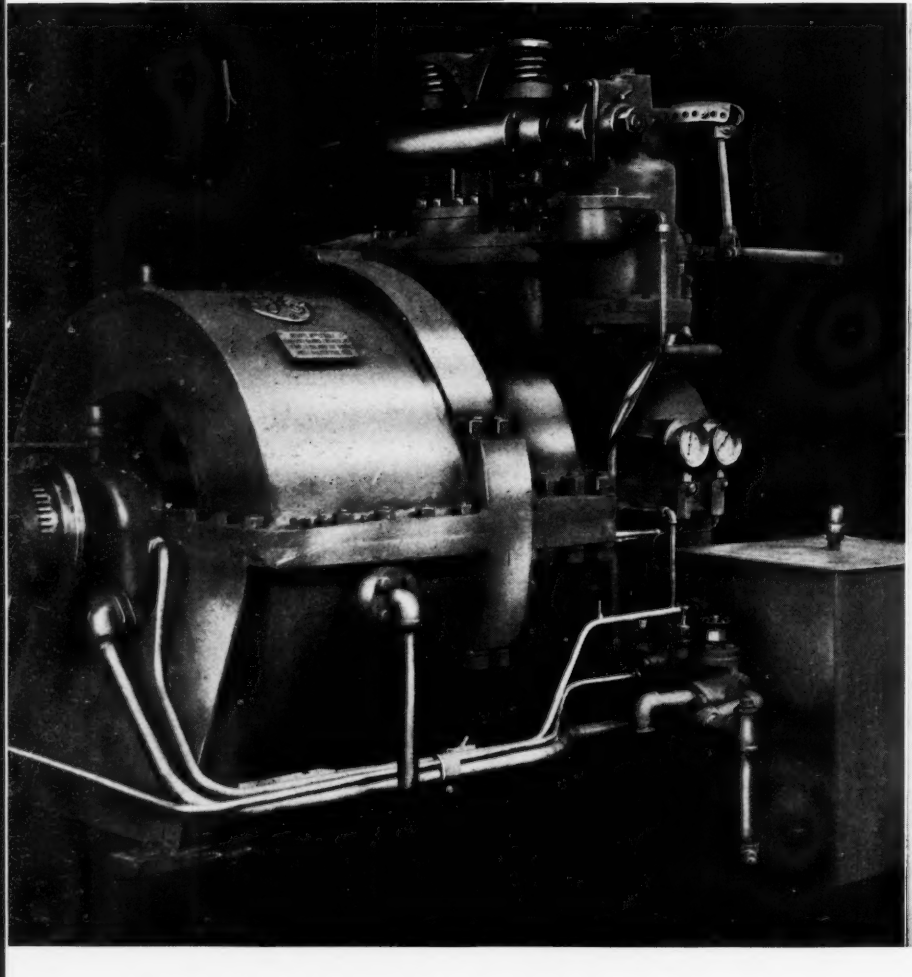
ıst ring and
rolled shell

Linde
Photo

CASTING PLUS

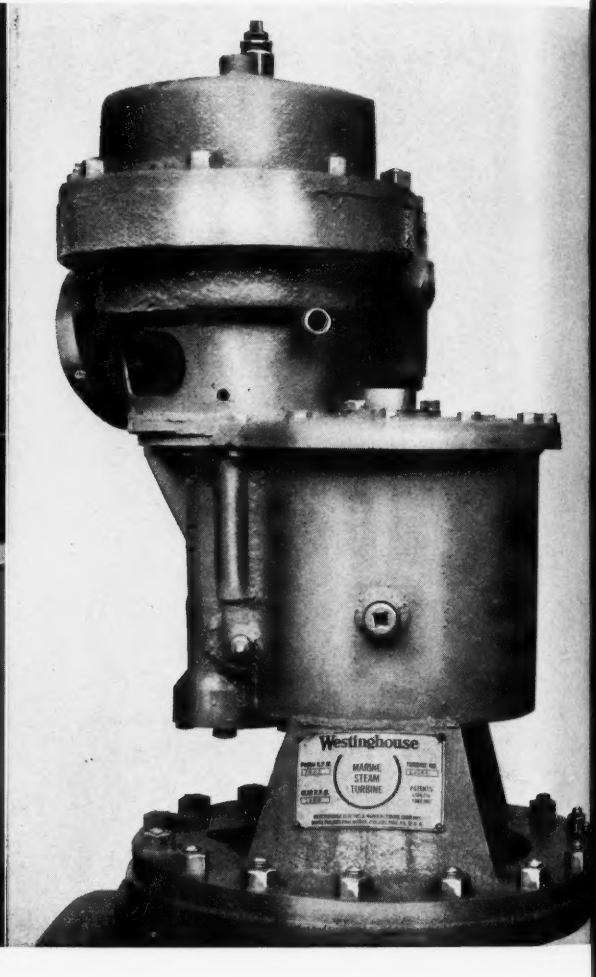
FOR BETTER POWER

Combinations of cast, forged and rolled parts



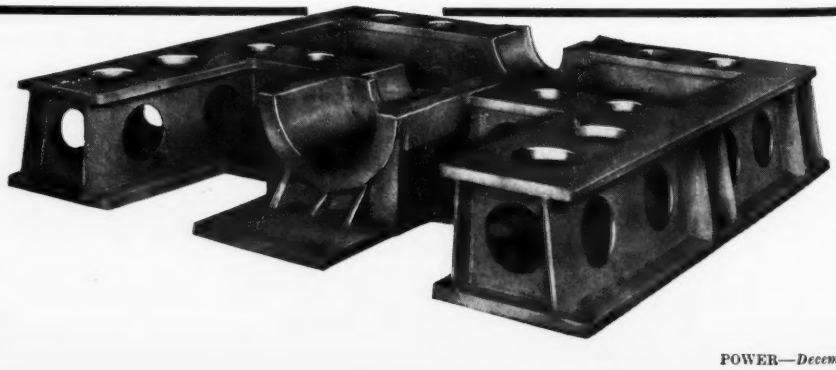
Steam turbine with arc-welded casing. The steam chest and front end of the upper half of the casing is a steel casting because of the complex chambering from the valve gear down to the first-stage nozzles. The balance of the casing is made from boiler plate, gas-cut and arc-welded into the assembly

Photograph General Electric Co.



Marine steam turbine with castings welded to rolled-plate parts. Parts which are complicated or have cored sections are cast, then welded into the assembly with the rolled steel elements of the turbine

Photograph Westinghouse E. & M. Co.

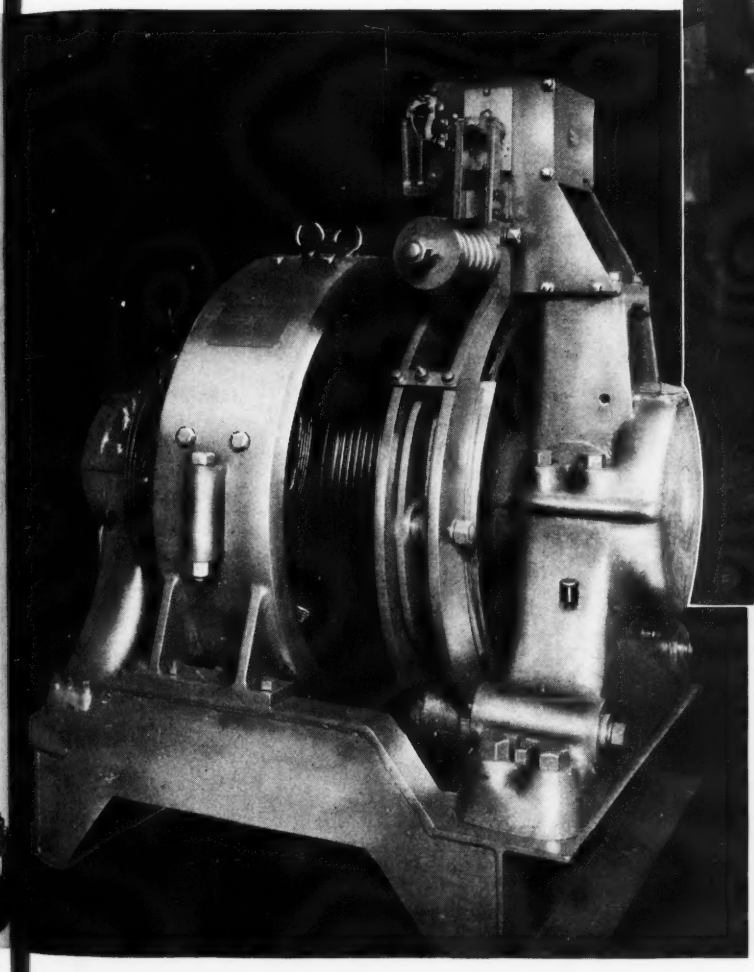


Right—Part of a base for a 1,500-hp. double-reduction main drive gear for marine service. The thrust bearing assembly is a welded-on steel casting

Photograph Lukenweld Inc.

WELDING EQUIPMENT

increase strength, economy

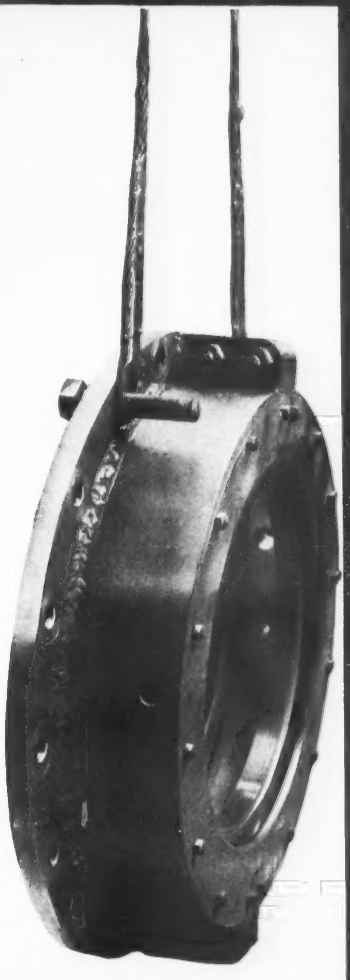


A 40-hp., 64-r.p.m., 230-volt, gearless fabricated elevator motor with cable sheaves and solenoid brake. Baseplate, housing and the solenoid supporting bracket are of steel plate, the bearings are cast. The various sections are assembled by electric arc-welding and bolting

Photograph General Electric Co.

Welding a cast-steel ring to the top of a circuit-breaker tank. The casting, having various difficult pockets and brackets, is welded on automatically after all machining operations have been completed. Lugs and lifting ears are welded in place

Photograph Westinghouse E. & M. Co.



Steam-turbine low-pressure packing case, fabricated from Ascoloy and machine steel, successfully arc-welded

Photograph General Electric Co.

for information concerning

COCHRANE *improved* EQUIPMENT

for modern steam plants

HOT PROCESS LIME-SODA WATER SOFTENERS — using phosphates for high pressure boilers.

ZEOLITE WATER SOFTENERS — where suited to plant and water conditions.

CONTINUOUS BOILER BLOW-DOWN SYSTEMS — which save heat and prevent priming.

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COMBINED DEAERATING HEATERS AND SURGE TANKS — which compensate for varying water content of boilers.

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MULTIPORT BACK PRESSURE VALVES — Safe and noiseless.

BOILER BLOW-OFF VALVES — which keep tight under highest pressures.

TRAPS, DRAINERS AND DISCHARGERS — having great capacities at all pressures.

PILOT-CONTROLLED REGULATING AND OVER-FLOW VALVES — for pressures up to 100 lbs.

PRESSURE FILTERS — for purifying swimming pool water, oily condensate, etc.

STEAM PURIFIERS — which protect superheaters and turbines, regardless of rate of driving boilers.

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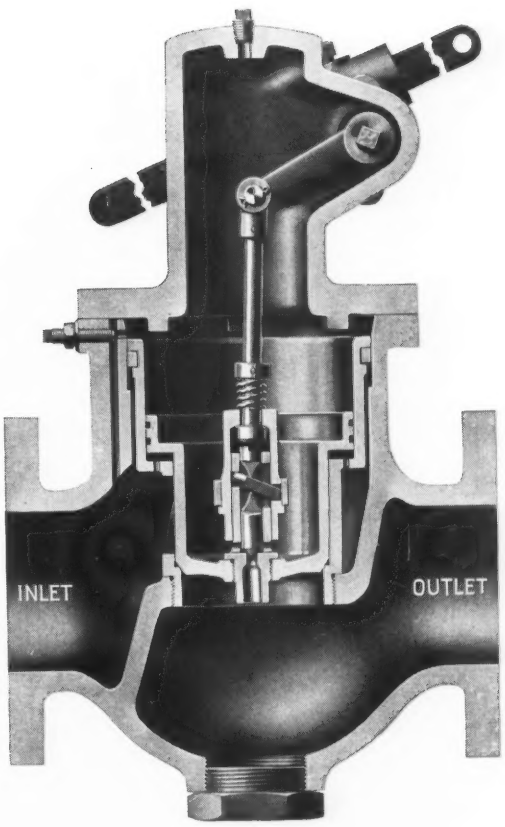
PERPETUAL MOTION may be a dream *but* Improved Equipment is a fact

If you will stop at our booth at the New York Power Show, it will give us much pleasure to demonstrate for you an apparatus which runs continuously, day and night, DRAWING ITS POWER FROM THE SURROUNDING ATMOSPHERE.

At the same time, we would like to show you an IMPROVED PILOT OPERATED REGULATING and OVERFLOW VALVE which works smoothly under high pressures, has a rate of discharge proportional to float displacement, and closes off DROP TIGHT.

Our engineers in attendance will submit for your inspection numerous photographs and drawings and information relating to the Cochrane improved equipment listed on the opposite page, by which you may improve the economy of your plant.



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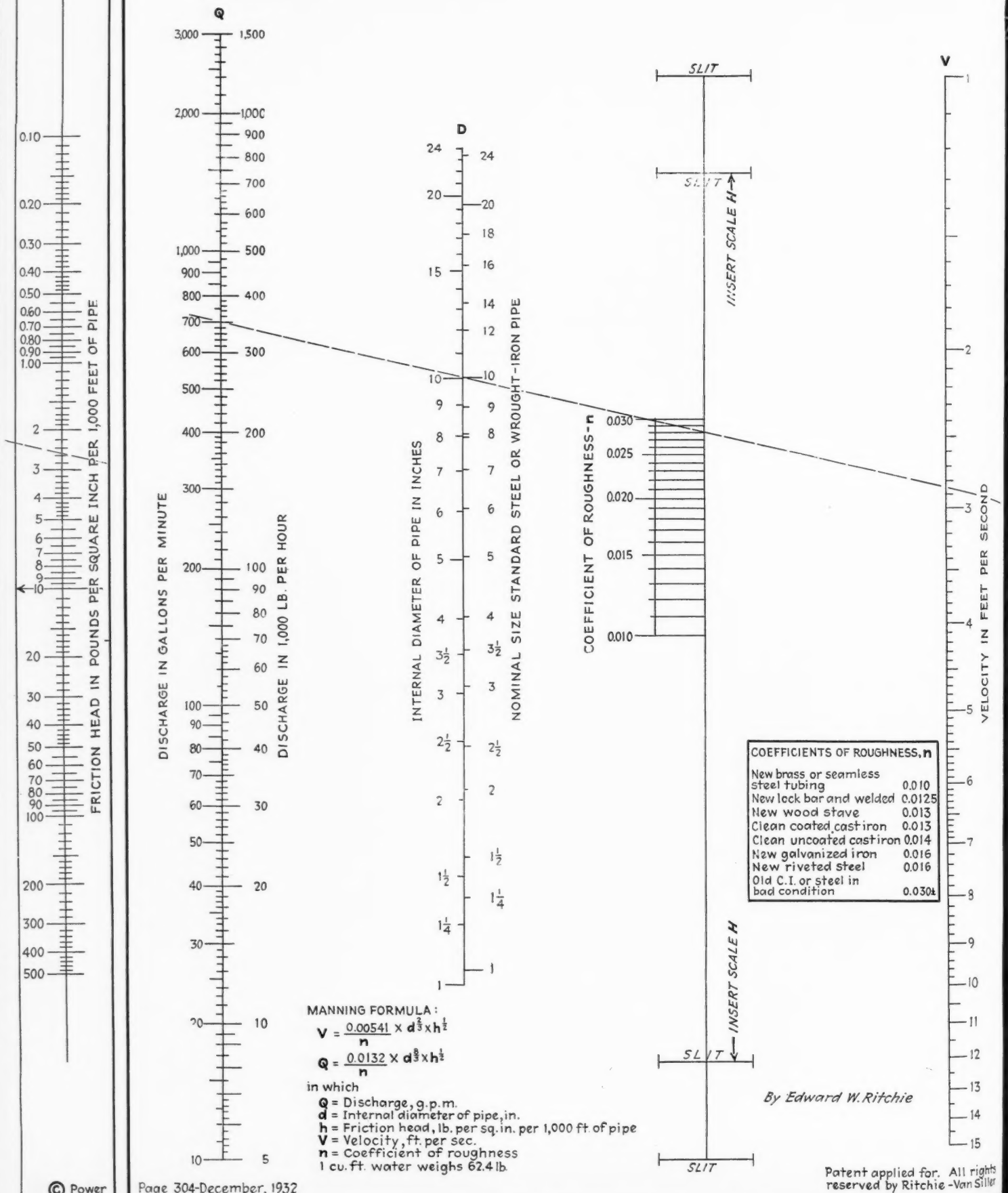
POWER'S DATA SHEETS

NUMBER 5

LINOGRAPH FOR FLOW OF WATER IN PIPES

To use this linograph, slits are cut as marked and the slide scale **H** inserted therein.
Set the arrow opposite the coefficient of roughness decided upon and proceed thus:

Example: Given a nominal 10-in. wrought iron pipe to discharge 700 g.p.m. Allowing for internal condition of pipe, 0.014 is selected as the coefficient of roughness, and the arrow on scale **H** is set opposite 0.014 on the **n** scale. Stretch a thread or straightedge from 700 on the left side of the **Q** scale through 10 on the right side of the **D** scale and continue it across the **V** scale. A water velocity of 2.85 ft. per sec. and a friction head of 2.5 lb. per sq. in. for 1,000 ft. of pipe are indicated.



COEFFICIENTS OF ROUGHNESS, n	
New brass or seamless steel tubing	0.010
New lock bar and welded	0.0125
New wood stave	0.013
Clean coated cast iron	0.013
Clean uncoated cast iron	0.014
New galvanized iron	0.016
New riveted steel	0.016
Old C.I. or steel in bad condition	0.030±

MANNING FORMULA:

$$V = \frac{0.00541}{n} \times d^{\frac{2}{3}} \times h^{\frac{1}{2}}$$

$$Q = \frac{0.0132}{n} \times d^{\frac{8}{3}} \times h^{\frac{1}{2}}$$

in which
Q = Discharge, g.p.m.
d = Internal diameter of pipe, in.
h = Friction head, lb. per sq. in. per 1,000 ft. of pipe
V = Velocity, ft. per sec.
n = Coefficient of roughness
1 cu. ft. water weighs 62.4 lb.

By Edward W. Ritchie

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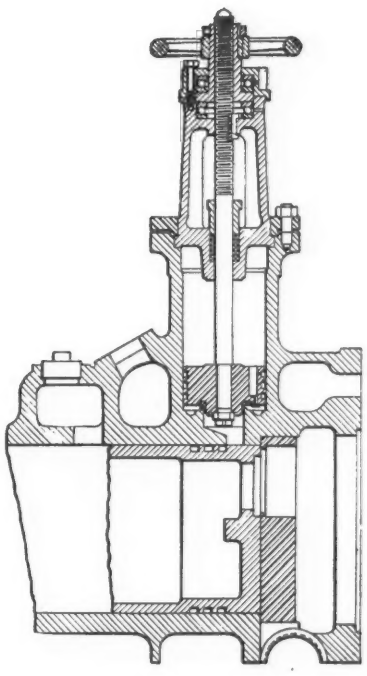
REGULATING COMPRESSOR CAPACITY

FOR VARIABLE REFRIGERATION LOADS

Unless compressor capacity is decreased as the refrigerating load drops, the power per ton of refrigeration will increase. Here methods of varying compressor capacity are reviewed and described

By LEON BUEHLER, Jr.
Frick Company



Clearance volume is increased and compressor capacity decreased by raising the piston operated by the handwheel

ONLY in rare cases do compressors handle a constant volume of gas at all times. Compression systems must in general, therefore, be equipped with some means of balancing the output gainst the load.

In refrigeration service, compressor output and the load are really self balancing. If the liquid refrigerant is properly fed to the evaporator so that none will slop over, only such refrigerant as is evaporated can flow to the compressor.

For example, consider an ice plant with two ice-making tanks when one of them is shut down but with the full compressing equipment in operation. The single ice tank will evaporate less gas by weight, and as the displacement of the compressor changes but little this gas must occupy a larger volume. It, therefore, expands to a lower pressure when it will have the volume demanded by the compressor. The discharge pressure of the compressor will not change much, so that with lower suction pressure there is a higher compression ratio. This results in a lowered volumetric efficiency, or, in other words, a somewhat smaller volume of gas will be pumped. With the lower suction pressure the temperature of the refrigerant in the evaporator will fall, giving a higher mean temperature difference between brine and refrigerant and hence a proportionately greater heat exchange. The evaporator will boil off a greater weight of gas when operating alone than in conjunction with the other tank. The result is, nevertheless, that the system operates at lower suction pressure with one tank than with two.

It is well known that the horsepower per ton of refrigeration increases as the suction pressure is reduced, so that the lowered pressure is undesirable. Furthermore, if the load is much too small for the compressor, the suction pressure will be at a vacuum, frequently resulting in air being sucked into the system. The compression ratio may even mount so high that a single-stage machine no longer operates satisfactorily due to the resulting high compression temperature interfering with lubrication and seriously damaging the machine.

Before proceeding to a description of devices for changing the displacement of compressors, consider what steps can be taken to balance the load against the capacity. The following list includes all of the possible solutions occurring to me:

1. Variable compressor speed.
2. A number of compressors operated to suit the load.
3. Intermittent compressor operation.
4. Putting one or more cylinders of a multi-cylinder machine or one end of a double-acting machine out of service. This may be accomplished by removing suction valves, disconnecting the connecting rod, or any other method of mechanically disconnecting the piston from the rotating shaft.
5. Variable stroke.
6. Preventing compression during part of the stroke

by keeping the cylinder and suction connected for a portion of the compression stroke proportional to the reduction in capacity desired. This may be accomplished by holding the suction valves open, by providing ports in the cylinder wall connected to the suction which will be covered by the piston when compression is to start, or by providing a port to the cylinder controlled by a mechanically operated valve which will close at the desired time.

7. Entirely preventing compression during a certain number of the strokes and operating full during the balance of the strokes. This also can be accomplished by holding the suction valves open when desired or by a separate port controlled by a valve and connected to the suction.

8. Variable clearance.

Other possible methods, such as bleeding part of the compressed gas back into the suction, have not been mentioned because of their obvious inefficiency.

Speed Control a Satisfactory Method of Capacity Regulation

The first of the listed methods is one of the most obvious and satisfactory because, neglecting friction, the compressor does not lose in efficiency. As long as compressors were steam driven, such regulation was most effective and simple and no other method needed consideration.

Today, most compressor drives are essentially constant speed. The speed regulation of oil engines is rather limited and the alternating current synchronous motor is of absolutely constant speed, and speed control of the induction type is only accomplished at a large loss of efficiency. It is true that motors are built to run at good efficiency at a number of different synchronous speeds by providing several sets of poles for the different speeds. Such motors are highly satisfactory, but it must be remembered that only two or three speeds can be obtained so that the capacity reduction will be in rather large steps.

With belted units several different pulleys may be used, but this involves too much time and labor for changes to be considered for anything but seasonal adjustments. There are also several variable-speed drives on the market. Changeable gear trains or step pulleys might be considered. None of these devices has found extended use.

A number of different compressors that can be operated in any desired combination to suit the load requirements will give all the flexibility required. In the very large plants where the individual units become large in themselves, a number of units can be bought as cheaply as one single unit of excessive size. Insurance against complete shutdown in case of trouble with one unit demands a number of machines in any event, and the problem solves itself. In the smaller plant it is undesirable and too costly to have several small units.

Intermittent compressor operation is the most usual method of balancing load against compressor capacity. In many cases such operation is demanded regardless of other methods of regulation. For instance, a milk plant will finish all work by early afternoon. Even if the milk is stored overnight the storage room temperature is maintained from a reservoir of cold brine or by the operation of a small automatic unit. The bulk of the work is done in a few hours, and the balance of the time the plant is shut down.

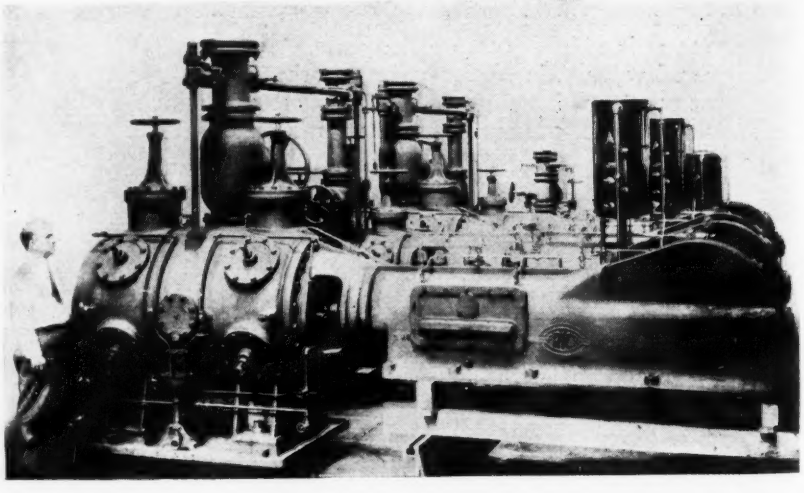
To overcome the resulting loss of efficiency, one or more cylinders of a multi-cylinder machine are often put out of service. This necessitates the partial dismantling of the machine, but for seasonal demands is well worth the labor. If such operation is intended, additional flywheel effect must be provided to assure smooth operation. This is especially true in connection with synchronous motors.

The author knows of no refrigeration compressors on the market with a variable stroke. Such machines could possibly be built, but it is questionable if they would be mechanically satisfactory.

There are machines on the market which change the effective length of stroke by providing valved ports at one or more points along the cylinder and connecting them to the suction. To reduce the capacity one half, the valve controlling the port at one-half stroke is opened, and during the first half of the stroke the piston forces gas back into the suction. The piston passing over this port closes it and compresses the gas remaining in the cylinder. Such machines should operate without appreciable loss in efficiency. The possible capacity reduction is confined to a number of steps conforming to the number and location of ports. Unless the ports are of liberal size, there will be some loss from wire drawing. A certain loss is inevitable as the gas must be slightly compressed in the cylinder to cause it to flow into the suction. It may be suggested that to get finer regulation the bypass valve should be throttled. This reduces the efficiency, as wire-drawing losses are magnified.

By holding open the suction valves mechanically or by providing a connection between the cylinder and suction controlled by a valve held open during a certain proportion of the strokes the capacity could be controlled. In the latter method care would have to be taken not to increase materially the clearance of the machine. I know of no such machines for refrigeration.

Two of six duplex ammonia compressors in the Amcelle plant of the Celanese Corp., equipped with clearance pockets for varying the compressor capacity



It is well known that clearance reduces the volumetric efficiency of compressors, or in other words reduces the volume of gas pumped. Most of the devices for control of capacity operate by varying the clearance. This can be mechanically accomplished in any number of ways. Usually one or more pockets are provided in the head. Communication between cylinder and pocket is effected by opening a valve. These pockets are of such size that opening one or more reduces the capacity by certain fixed steps. Another design uses a cylinder fitted with an adjustable piston to provide the additional clearance. The piston can be set at any desired position to give any reduction wanted within the limits of the device.

In using clearance pockets with multi-cylinder machines it is best to regulate all cylinders equally instead of making all of the capacity reduction on one cylinder. This precaution will prevent jerky operation of the machine and will keep down surges in the electric lines. In adding clearance to a compressor there will be more heating of the discharge gas, and effective water jacketing is most important.

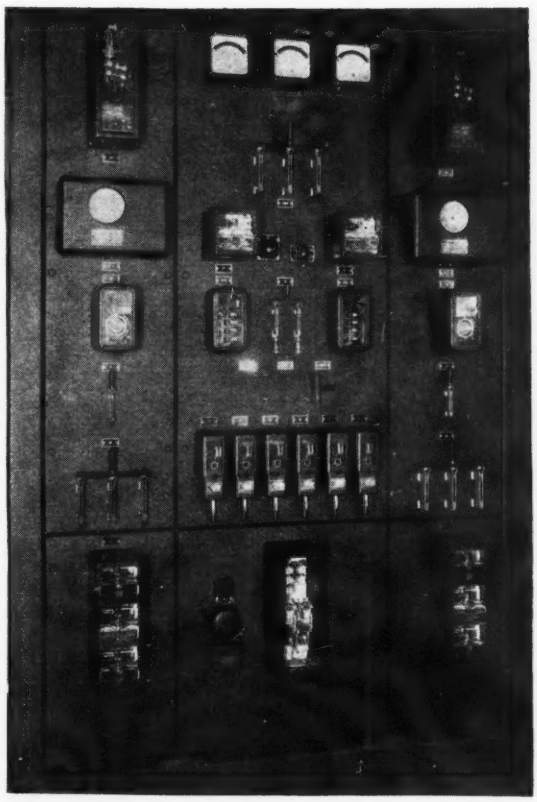
As a matter of fact, in all of the devices described the efficiency at reduced capacity is lowered, but in a well-designed machine this difference should not be very great. The saving by operating at higher suction pressures far outweighs the loss of efficiency in the machine.

Although such machines will pay for themselves in most plants, nevertheless, where conditions are such that the plant will operate at reduced capacity a large part of the time, two units should be installed, for as already stated the reduction of capacity does lower the efficiency of a compressor.

▼ ▼ ▼

AUTOMATIC PUMPING STATIONS

Report Their Own Status



Automatic switchgear for motor starting and supervisory equipment for pumping plant

SO COMPLETELY automatic are the new Pikesville and Townson pumping stations for the Baltimore, Md., bureau of water supply, that it is merely necessary for headquarters to call the unattended stations on the telephone if reports of operating conditions are desired. A unique method of obtaining these automatic reports was designed for the purpose by General Electric engineers, and was recently put into operation.

The pumping equipment, two motor-driven pumps, is automatically started and stopped in accordance with the water level in the reservoir. A hand-operated switch in the pumping station makes it possible to predetermine which pumping unit shall start in response to the water-level indication, but, should this preferred unit shut down because of trouble or some other reason, the second unit is automatically started in its place.

By means of the special audible indicating equipment, operators can obtain reports of the conditions in the pumping station from any point which has telephone connection with the station. The pumping station number is dialed in the usual manner, and the indicating equipment is immediately set in action. The desired information is transmitted by means of a series of codes made up of long and short buzzes heard in the telephone receiver. The different codes are separated by a single-stroke bell signal also heard in the telephone receiver.

The first report transmitted by the code tells whether or not conditions generally are satisfactory and correct at the station. In that event, the equipment continues its report, telling which of the two pumping units is selected as the preferred one; whether water is flowing into or out of the reservoir; what the water pressure is in 5-lb. steps from 50 to 70 lb.; what the water level is in the reservoir in one-foot steps over a six-foot range. If the first report, however, showed that the station was not in satisfactory operating condition, then an additional set of codes is transmitted, indicating whether or not voltage is available for each of the pumping units, and whether or not either unit is locked out of service because of the functioning of some protective device.

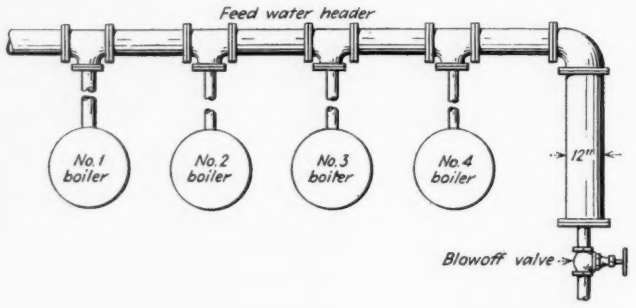
When the audible equipment is once started, it proceeds to report on all the various conditions described and then repeats the code signals as a check. If, however, someone is visiting the pumping station and wishes to answer the telephone he may do so without interference from the audible indicating equipment because it is disconnected from the telephone as soon as the receiver is lifted. If the visitor wishes to call out of the station, he may do so in the usual way.

PRACTICAL AIDS TO OPERATION

Boiler-Tube Failures Reduced by Extending Feedwater Header

In many boiler plants where a number of boilers are operated in a battery, feedwater passes through a header in front or at the rear of the boilers to the individual feedwater lines. In most cases the feedwater header comes to a dead end at the connection to the last boiler in the battery. This may be by an elbow or by a blanked tee, but in either case there is a possible chance for trouble.

In one plant operating 400-lb. water-tube boilers the last boiler taking water from the feedwater header gave



trouble by tube failures. This boiler was the same size and was operated under the same conditions as the others, but was the only one to give trouble.

It will be found that even though soft water is fed to boilers, a scale may form that may cause boiler tubes to blister and last but a short time. It seems that the solids entrained in the water are carried through the feedwater header to the last boiler taking water from it. This is probably because the impurities are slightly heavier than the water and will not change direction of flow quickly.

By continuing the header into a piece of 12-in. pipe mounted vertically this trouble was remedied. A blow-off valve was installed at the base of the pipe which may be from 5 to 20 ft. long depending on the available headroom. By sampling the water in the vertical line at intervals the proper frequency of blow-down was readily determined. Harry M. Spring.

Milford, N. J.

Five Men — Fourteen Bolts

Power readers may be interested in the following experience of the writer, which was entirely unexpected in these days of depression, although very probably in the boom period of 1928-1929 it would have been passed by without comment.

The company for which I work as field man recently sold a drainer to one of the large public utilities companies. After it was placed in service, it was found necessary to examine the interior for the purpose of installing some special parts. To do this I had only to remove the cover casting, which is attached to the body by means of fourteen $\frac{3}{4}$-in. stud bolts.

As the equipment had not been finally turned over to the operating force, it was necessary to arrange for this inspection through the engineering organization responsible for the additional equipment being installed in the plant. When making this arrangement I was advised that I would not be permitted to remove this cover myself; this would have to be done through the operating force there.

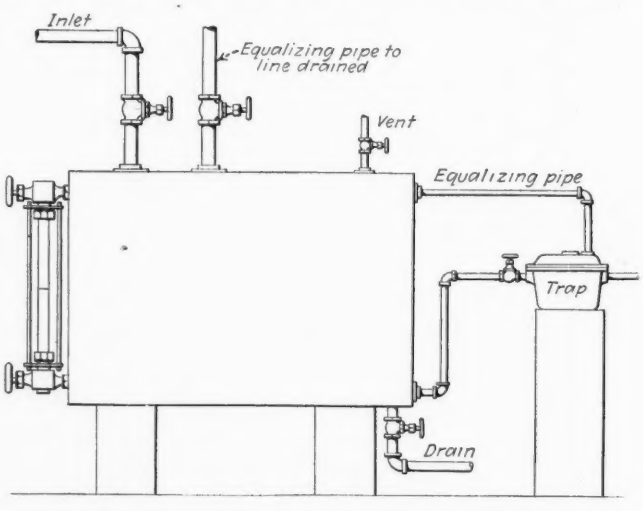
On arriving at the plant I had to apply to the assistant superintendent of the engineering construction company, who in turn reported to the foreman in charge of the pipe-fitting force. He in turn assigned two of his men to do the work, and I then had the opportunity of seeing five men, including myself, standing around the piece of equipment while two of their number removed the nuts from the fourteen $\frac{3}{4}$-in. bolts and lifted the cover off, and then, after the new parts were slipped into place, put the cover on again.

This sort of thing very probably is helping to avoid unemployment to some extent, but it is certainly not helping to reduce the cost of construction or to reduce the price of electricity to the consumer. H.D.E.

Brooklyn, N. Y.

A Separating Tank to Keep Oil Out of Traps

The diagram shows how a closed tank was used as a receiver and separator for returns and drips containing oil to keep the oil from passing through the trap. The returns enter the tank through the inlet at the top of the

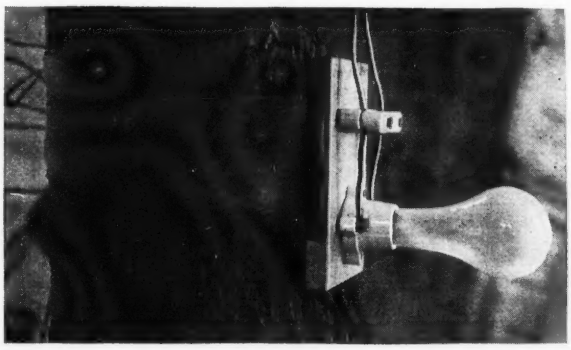


tank and the oil rises to the surface of the water. No water enters the trap until its level is above the horizontal section of the intake pipe to the trap. All water passing through the trap is taken from the bottom of the tank where it contains the least oil. To drain the oil from the tank, the inlet valve is closed and the vent and drain valves opened. G. B. Longstreet.

Matawan, N. J.

Emergency Light or Switches Mounted on Columns

OCCASIONS often arise when it is necessary to fasten emergency lights or switches on poles or columns. The photograph shows how this was done easily and quickly with things that are readily obtained. The lamp socket



was mounted on a piece of 1-in. board which was held in place by a piece of rubber cut from an old tire inner tube. The rubber was stretched to give it tension and tacked to the sides of the block, which gave a secure mounting for the lamp, yet one that could be taken down easily.

F. W. BENTLY, JR.

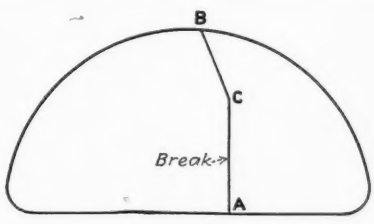
Missouri Valley, Ia.

Hints for Doing Welding Jobs About the Plant

RECENTLY while inspecting a squirrel-cage induction motor prior to giving it an overhauling, it was found that the speed was 60 r.p.m. below normal, caused by loose bars in the rotor. Originally these bars were soldered to the end rings but it was decided that bronze welding would hold them better.

The welding torch was applied, but the copper bars conducted the heat away so rapidly that it was impossible to melt them enough to mix with the bronze. This difficulty was overcome by placing the rotor on end in water leaving the bar ends and rings just above the surface. The water kept the heat from passing to other parts of the rotor and the welding was successfully completed. All rough spots were taken off in the lathe and when assembled the motor ran at normal speed.

On another occasion a large cast-iron door that was broken in two had to be welded. The weld was started at *A* in the diagram and made toward *B*. Before the job was completed, however, the weld cracked due to strains caused by heating and cooling of the metal.



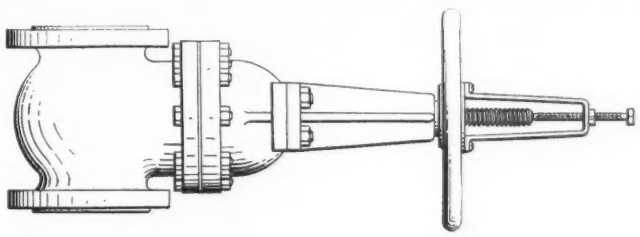
To overcome this, the pieces were tacked at *A*. *B* and *C*, leaving spaces in between. The metal along the break was then kept heated by plying the torch back and forth until the weld was completed without further difficulty.

Lowell, Mass. CLARENCE W. HOPE.

[Subsequent checking up with American Brass Co. and other sources of information on copper welding provides contrary evidence on the welding-in-water method. Pieces set in water have been welded, but were only handled in this way to prevent discoloration, and more heat was required since water conducts heat away about four times as rapidly as air. If this were not true quenching of pieces to temper them would be impossible. Further pertinent discussion will be welcomed.—Ed.]

Limit for Setting Valve Opening

IN OUR plant we wished to arrange one of the gate valves with a rising stem so that it could be opened and closed a definite amount repeatedly without measuring each time or depending upon counting the turns made with the valve wheel. This problem was solved by making a fitting to go on top of the hand wheel and bridge the valve stem, as in the figure. An adjusting screw in the top of the fitting allowed setting a limit on the valve opening. After the valve had been opened to the



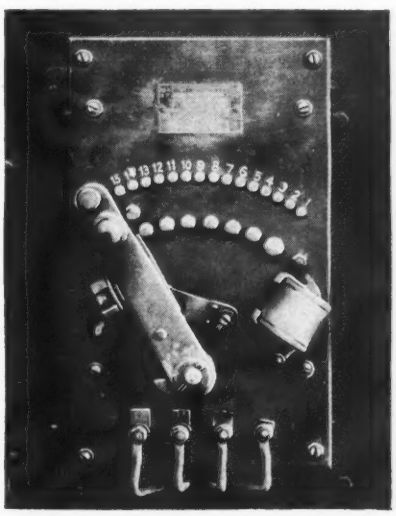
desired amount the limit screw was brought down on top of the stem and locked in place by the lock nut. The valve could then be closed and opened again the same amount as before.

EDWARD B. BLACK.

Jeanette, Pa.

Marking Controller Points Simplifies Coal-Pulverizer Operation

WE HAVE two large pulverized-coal fired boilers, each fed by two unit-type pulverizers. The pulverizers are direct driven by a large alternating-current motor and are constant speed. To vary their output, each machine is equipped with a 1-hp. variable-speed direct-current motor connected to a rotary feeder supplying the pulverizer hopper.



The direct-current motor controllers use resistance in the armature circuit to start and resistance in the field circuit to regulate the motor speed after it reaches minimum speed of

about 900 r.p.m. To assist the fireman in dividing the load equally between burners each field point has been numbered in yellow enamel, as in the figure, beginning with one as the lowest speed. We have found the open-type controller more desirable than the closed type because its position is easily seen, whereas it is mostly guesswork with the closed type. T. E. MILLER.

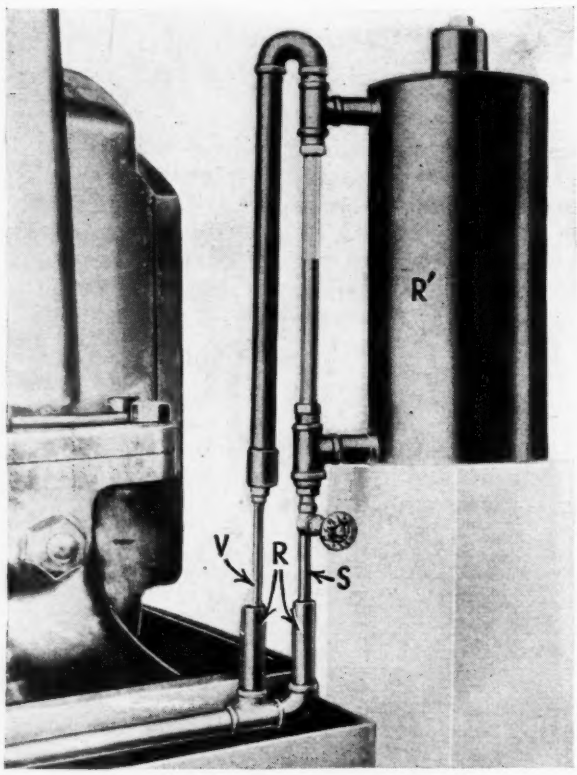
Nashville, Tenn.

Oil Supplied Automatically to Engine Crankcase

AN ENGINEER having charge of several diesel and gas engines in a municipal plant decided that the method used to maintain a supply of oil in the crankcase could be simplified. Accordingly the equipment shown in the figure was devised. This apparatus has no moving parts but depends upon gravity and vacuum for its operation.

A supply of oil for the crankcase is stored in the reservoir *R'*. On the crankcase oil-supply pipe are two risers *R*. These connect to the oil reservoir by a supply pipe *S* and a vent pipe *V*. The end of the supply pipe extends about 1 in. further into its riser on the crankcase supply line than does the vent pipe.

When the oil level in the crankcase and the risers drops to where air can pass up the vent pipe, oil will flow from the reservoir into the crankcase. As the oil



in the riser reaches a level to close the vent pipe the pressure above the oil in the reservoir will be reduced to a point at which flow into the crankcase will cease. When the oil level in the crankcase again falls to a point at which air is admitted through the vent pipe to the storage reservoir, oil will again flow to the crankcase to restore the proper level.

An oil gage on the reservoir shows at a glance the available oil. All that the engineer has to do is to maintain a supply of oil in the reservoir and the rest of the operation is taken care of automatically.

The oil reservoir was made of a piece of 12-in. pipe about 24 in. long with welded steel-plate ends, a filling plug being provided on top of the tank. The tank should be placed only high enough for its bottom to be slightly above the oil level in the risers from the crankcase, so that the oil will have little dynamic head, but sufficient to induce proper flow when the vacuum is broken.

A similar method of supplying oil to engine crankcases was described by the writer in *Power,* page 826, May 21, 1929. That system's operation depends upon building up pressure in the oil-supply tank, but it is limited to crankcase compression engines. ORVILLE ADAMS.

Dallas, Texas.

Making Load Tests on Three-Phase Motors

WHEN it is possible to do so, protective equipment of important motors should be tested for the tripping current under actual service conditions. To make the test, a voltmeter, ammeter and one or more thermometers with Centigrade scales should be used. One thermometer should be inserted between the coil noses of the winding near the top of the motor, and another should be fastened to the core iron, using a pad of cotton batting or some putty to protect the bulb and exclude outside temperature. The room temperature approximately three feet from the motor should be taken before and after the test and the average value recorded.

If the nature of the motor load is such that it can be increased conveniently, raise it to the point where it will cause the relay to trip within approximately ten minutes. This may be taken as the tripping current of the relay under service conditions. Reduce the load to the maximum current that the relay will carry continuously, allow the motor to run at this load and take instrument readings at not more than 15-min. intervals. The temperature of the motor may be considered stable when it varies less than the one-half degree in 15 minutes. If the motor temperature rises above 80 deg. C., the relay rating should be reduced.

In many cases the load on the motor cannot be increased above normal, making it impossible to take an overload test in the usual way. However, the tripping current for the relay may be obtained by other means, and at the same time the value of the protection against single-phase operation can be checked.

First, reduce the load current approximately 50 per cent, and with the motor running, pull out one line fuse. In the case of large motors, break one line by using a temporary switch, and allow the motor to run single phase. It will then take approximately the same current from the line as it did running three phase at normal load.

The load should now be increased to the point where the relay trips in ten minutes, and as in the case of the 3-phase test, it should then be reduced until the relay will just carry the current continuously.

Take voltage, current and temperature readings as before, but in this case it is important to see that the thermometer is placed against an active part of the winding, otherwise the maximum temperature rise will not be obtained.

If the temperature is above 80 deg. C. the relay rating should be reduced. Knowing the current required to trip the relay under service conditions and the current required to raise the temperature of the motor to 80 deg. C. running single phase, the degree of protection for three-phase operation can be approximated.

Toronto, Ont. H. WILSON.

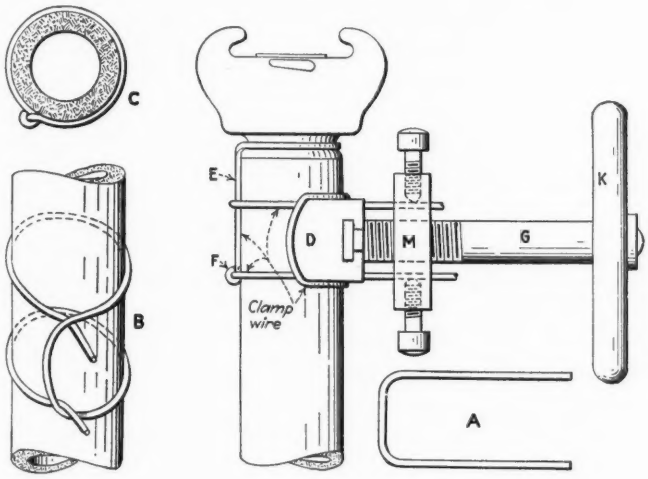
Heavy Wire Clamp Connects Hose to Couplings

IN THE plant where I am employed a large amount of compressed air is used and hundreds of feet of air hose are in daily service. Instead of using the regular type of clamps on the hose couplings our machine shop has adopted a heavy wire type that will hold against 100 lb. per sq.in. This type has the advantage that there are no clamp bolts to catch on objects when the hose is being dragged from one place to another. The wire clamp is drawn so tightly by a simple tool that it sinks into the rubber and leaves practically a smooth surface.

The diagram shows the tool for putting on the clamp and how the clamp is applied. Head *D* of the tool is about $\frac{3}{4}$ in. long by $\frac{3}{4}$ in. wide and $\frac{1}{2}$ in. thick at the screw. Its front end is tapered to about $\frac{1}{4}$ in. thick, with a groove to hold the wire. The tension screw can be made from an old valve stem on a piece of $\frac{5}{8}$-in. round steel, and the hand wheel *K* can also be from an old valve. Block *M* for tightening the wire is about $1\frac{1}{2}$ in. long by 1 in. wide and $\frac{1}{2}$ in. thick, tapped for $\frac{1}{4}$-in. set screws. The holes for the wires are about $\frac{1}{8}$ in. in diameter.

To clamp a connector, first take a length of soft iron wire of sufficient length to go around the connector's neck and leave ends about 2 in. long. Place the connector in the hose and bend the wire back over the hose as at *E*.

Next take another piece of wire long enough to go around the hose three or four times and bend it into the shape shown at *A*. Lay the wire against the hose and bend it to form loops as at *B* and place the loops near the end of the hose over the connector. Insert the two ends of the wire into the holding block *M*, and fit the loop of



the wire into the head *D*. Tighten the set screw to hold the wire ends in block *M* and tighten the wire around the hose by turning the hand wheel.

When the wire is sufficiently tight, rotate the tool around the hose so as to bend the ends of the wire around the connection between the two loops. This will form hooks to prevent the clamp from coming loose when the set screws are loosened and the tool removed. The ends of the wire are now cut off and hammered down to form a tight connection around the connection between the loops, and wire from the connector is looped around the clamp as at *F*. Wire *E* is to prevent the connector from being pulled out of the hose. Two wires similar to *E* may be used one on each side of the hose, if desired.

This type of clamp may be used to splice a hose to a nipple. Two clamps are used over two or more parallel wires running between the connectors.

Rockland, Mass. BURTON W. WHEELER.

Automatic Starter Replaced by Manual in Emergency

A CONTROLLER of the type shown in Fig. 1, used on a pump motor, failed, was flooded with water and had to be taken out for repairs and drying. It was necessary

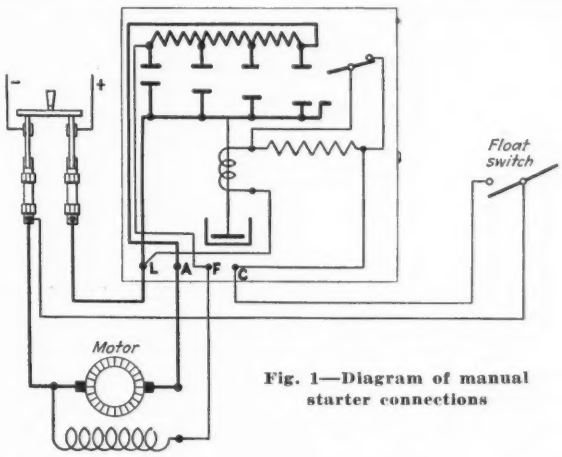
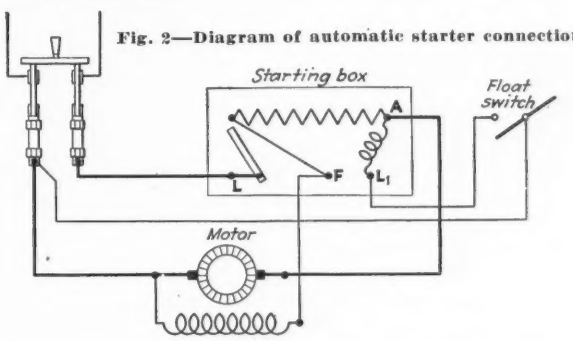


Fig. 1—Diagram of manual starter connections

Fig. 2—Diagram of automatic starter connections



that the pump be kept in operation, but the only starting device available was of the manual type having the holding coil connected across the line.

This starting box is connected to the motor and float switch as in Fig. 2. Although the pump has to be started manually it is shut down automatically when the float switch opens and breaks the holding-coil circuit. The starter will also give an indication of the height of the water in the tank. If the water is at a level where the float switch is held open and the pump is started, the holding coil will not keep the starting arm in the running position. This will show the attendant that the water level in the tank is high enough to hold the float switch closed and give him some idea of how long to wait before low water will obtain.

Cleveland, O. C. A. ARMSTRONG.

CURRENT COMMENT

Bending Copper Pipes

HAVING read with interest the short article by W. E. Warner in the September number of *Power,* the writer desires to add a few more notes on the art of bending copper pipes for power plants.

In the first place, however, there is one material suggested in Mr. Warner's article for filling copper pipes prior to bending which is not satisfactory, namely, molten lead. It is one of the worst of metals in its ill effect on copper. Moreover, it can rarely be absolutely cleared from the interior of copper pipes, even when the precaution is taken to coat the inside of the pipes with claywash. During subsequent heating the lead residue is likely to eat its way into the surface of the copper.

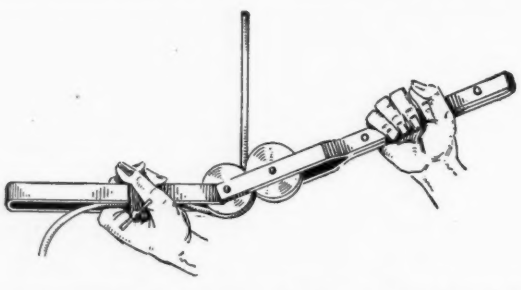
As an illustration of the evil effects of lead or lead-tin alloys on copper, observe the energetic action that takes place as a strip of copper with a small piece of lead on it is heated over a fire or torch flame to a good red heat. After cooling, carefully examine the surface of the copper acted on by the lead, remembering at the same time that the longer the copper is heated the deeper the lead will penetrate. This is the action which takes place on the bends of copper pipes when heated after having been treated with lead.

Experience teaches that all bends in ordinary plant practice can be shaped on rosin, or rosin and pitch. A snugly fitting coiled spring may often be used advantageously to prevent flattening of small diameter copper pipes at the bend. One method of removing the spring after the bending operation is to fasten one end of the spring to a lathe spindle, which is then rotated so as to wind the spring in whatever direction will reduce its diameter. The spring should be lubricated before using.

Dry sand, well tamped down, and with the pipe ends plugged with wooden plugs so that all the sand will be retained, is an excellent method of filling copper pipes prior to bending.

Mr. Warner suggests that previous annealing can be dispensed with where sand is used for filling. This is permissible, providing suitably tempered copper pipes are used, as also is the case when either resin or pitch are used as filling materials.

A simple method for annealing copper pipes of small diameter uniformly is to put the copper pipe inside a



piece of wrought iron pipe sealed at one end and to heat the assembly in a forge for 20 to 30 min., according to the thickness of the pipe. The fire should be built well up around the pipe. The correct annealing temperature for copper pipes is about 1200 deg. F.

A useful, hand-operated tool for bending small-diameter copper pipes is shown in the illustration. The two hand lever parts are made from four pieces of $1\frac{1}{2}$x$\frac{3}{8}$-in. iron bar about 15-in. long. After shaping four ends to accommodate the rotating forming rolls, the hand lever ends may be welded together. The two forming rolls are turned out of cast-iron disks, and the grooves in them are such that when the forming rolls are placed almost together, the pipe fits loosely between them. The rolls are drilled to suit the studs, and are faced up on both sides. An adjustable clamping arrangement for holding the pipe during the bending process can be readily provided.

Whenever a pipe is bent, the outer fibers of the curved section are stretched and the inner fibers are compressed. Between these sections that are subjected to tension and compression there is a neutral axis located about midway between the inner and outer curves. Therefore, it is good practice to locate the seam in butt-brazed copper pipe along its neutral axis or section, in order to lessen the danger of rupture or cracking. A. EYLES.

Manchester, Eng.

Synchronous Motor Trips Running Switch When Started

I WAS interested in S. Ein's short article, "Synchronous Motor Trips Running Switch When Starting," in the October number. Although Mr. Ein found a solution to his difficulty in starting the motor, he did not give the correct cause of tripping of the switch. It is suggested that the cause of tripping of the switch by the motor was that the field of the motor was not given time to build up. As a matter of fact, the motor was not given time to pull into synchronism before switching from starting to running voltage.

Synchronous motors are started in several ways, depending upon their design and the kind of load they are driving. Most of the earlier types of synchronous motors were started on part voltage. If the starting load was light the field switch was closed, after the motor had accelerated nearly to full speed, and it was allowed to pull into step before switching to full voltage. Where the load was considerable at near synchronous speed, the motor was connected to full voltage without field. When it had accelerated to as near synchronous speed as possible, the field switch was closed after which the rotor pulled into step.

Ten or more years ago, motor manufacturers and operators began to realize that a slow-speed motor could be connected directly to full voltage and would take a lower starting current than a high-speed motor on reduced voltage. This was the beginning of full-voltage starting.

Full-voltage starting is now used on a large percentage of the synchronous motors in use today, particularly the slow-speed and medium-speed types. These motors are started by connecting them directly to the line, and when the motor has reached nearly full speed, field is applied and the rotor attains synchronous speed.

Buffalo, N. Y. C. O. MILLS.

Protecting Polyphase Motors Against Single-Phase Operation

On page 884 of *Power* for June 14 the statement appeared that a 55-deg. C., 50-amp. induction would be adequately protected against single-phase operation by the use of 60-amp. fuses. By applying the multiplier 1.15 to the full-load current of a 40-deg. motor its ultimate temperature will be the same as that of a 55-deg. motor. With the standard ambient temperature of 40 deg. the hot-spot temperature of the windings of both motors would be about 105 deg. C. This is the limit for Class A insulation which is ordinarily employed in motors. Since a 40-deg. motor can carry 1.15 times rated full-load current continuously, its fuses must be large enough to make this capacity available. The 55-deg. motor obviously has no overload capacity, and completely enclosed motors have this high-temperature rating. The 40-deg. rating applies to open, general-purpose motors that are so extensively used. Thus, 60-amp. fuses would be used to protect a 43.5-amp., 40-deg. motor, for its permissible full-load current is 43.5 × 1.15 or 50 amp.

An approved fuse will carry 110 per cent of rated current continuously. Thus a 50-amp., 55-deg. motor protected by 60-amp. fuses could draw at least 66 amp., or 132 per cent of maximum full-load current. This corresponds to 152 per cent of 43.5 amp., which is the motor's current at the 40-deg. rating. If the fuse's rating was 125 per cent of 50 amp. or 62.5 amp. it would carry 68.7 amp., or 158 per cent of maximum full-load motor current, this being the value quoted by Mr. Wilson. However, 62.5-amp. fuses are not listed. Mr. Wilson is certainly correct in pointing out that a 55-deg. motor continuously subjected to 132 per cent overcurrent would operate at a dangerous temperature. And when it is understood that the minimum melting current may be as great as 125 per cent of the fuse's rating, motor protection apparently disappears. But the picture is not so dark if certain factors are given due weight:

1. Most induction motors have capacity in excess of that required by the load because of a natural desire to provide ample power. Therefore overloads ordinarily encountered are not great enough to cause dangerous heating.

2. In most cases a motor or its fuses, if operating at a dangerous temperature, will attract attention because of odor of hot insulation, or by touch of the hand on the motor's hot frame. Consequently, prolonged operation at dangerous overloads is not likely to occur without being detected.

3. Overloads of brief duration are generally not harmful, and those of great severity, such as would be caused by a breakdown or jamming of the driven equipment, will promptly blow fuses if not rated larger than 125 per cent of the motor's continuous full-load current.

4. Dangerous motor overloads are anticipated and prevented by modern maintenance methods now followed by many motor users, and this practice is spreading because it helps to pay dividends.

5. Motor failures are caused chiefly by oil-soaked windings, dirt and rubbing rotors, not by overloads, notwithstanding that many motors are protected by fuses.

A correction must be made in the multiplier for approximating single-phase current. In practice it will be found to be about 2.0 instead of 1.7, this being the value given in the June 14 number. This increase in current will cause early blowing of the fuses on single-phase operation if the motor's output is above 80 per cent of its continuous full-load rating. Ray Barr Glenn.

Oakland, Calif.

Venting Boilers Before Going on the Line

That Mr. Emmons' experience, as told in the September number of *Power* concerning the drop in vacuum caused by air from boilers entering the condenser is not confined to his plant alone is indicated by the following letters:

Various methods are used for getting rid ot the air present in the boiler before putting it on the line. Some boilers without superheaters have a vent at the top of one of the drums through which the air is exhausted. Such valves are connected to open-end lines and are left open until some pressure is raised, and in the judgment of the operator all the air possible is exhausted.

Plants having superheaters some times allow the drains from the superheater headers to remain open. This, in addition to releasing the air, frees the superheater of moisture and establishes a flow through it. Good dry steam should be discharging from their open vents before the valves are shut. Types and fire conditions will govern the pressures at which this condition exists. Some boilers have both the drum vents and the superheater drains that can be used.

Plants using low pressure turbines, where the initial nozzle pressure is only a few pounds above atmosphere, have to be very careful about air entering the lines as most of the blading is at a pressure below the atmosphere and are more susceptible to vacuum drops than are the higher pressure units. Geo. B. Longstreet.

Matawan, N. J.

If a vent is provided at the highest point on the superheater outlet and is left open until steam is raised to 20 or 30 lb. pressure no trouble will be experienced with air causing vacuum drop.

For many years I have used a vent attached to the highest possible point of steam outlet and find it beneficial in cutting time of raising steam as well as avoiding condenser trouble. C. A. Green.

Cleveland.

In some plants a small valve is placed on the boiler side of the main stop-valve, which is opened just before placing the boiler on the line, allowing air and steam to blow out to atmosphere. In other plants the water column is made use of for this purpose. The water cock is closed, and steam cock and drain cock left open until 20 to 30 lb. pressure is raised.

I prefer the latter method. Air is heavier than steam and will lie close to the water level of the boiler during the comparatively non-turbulent period of raising steam. To blow the pop-valve on the superheater may release the air from the superheater, but I should not expect much air to be removed from the boiler drum. Using both superheater pop-valve and water column will, I think, give better results. E. Scott Rivett.

Noranda, Quebec.

READERS' PROBLEMS

MAGNET SWITCH STAYS CLOSED—*On one of our crane controls a 220-volt alternating-current magnetic switch stays closed sometimes; and at other times it apparently operates freely. Is it residual magnetism that causes the switch to remain closed, and how can this be prevented?* R.B.

The switch may be so worn that at times the frictional resistance to its movement may be sufficient to hold it closed. All parts of the switch should be carefully inspected, and if any are found worn they should be renewed. In any event, it will be advisable to take the switch apart, give it a good cleaning and lubricate any bearings that are subjected to movement.

Most modern magnet switches are so designed that their contacts close against the pressure of strong springs, which exert a powerful force to open them when the armature is released. It may be that, if the switch is of that type, the contact springs have become broken or have lost their tension. This should be looked into carefully, and if there is any doubt about the springs, they should be renewed.

It may also be possible that the contacts weld in the closed position. This should be indicated by burned spots where they come together. Welding of the contacts may be caused by sluggish action of the switch, insufficient tension in the contact springs, a rough surface on the contacts, or the contacts may be of insufficient capacity for the service they have to perform.

A short-circuit or ground may exist on the control wiring that allows sufficient current to leak through the magnet coil to hold the contactor closed even when power is apparently cut off from the motor.

A magnet switch that has a tendency to intermittently stick closed when its coil is deenergized is sometimes difficult to correct without replacing parts that have become worn. Frequently new parts for those worn is the only cure.

ADVANTAGES OF STAR-CONNECTED AND DELTA-CONNECTED MOTOR WINDINGS—*Why are some induction motor windings star connected and others delta connected? Has one system any advantage over the other?* C.A.A.

When it will conveniently satisfy the conditions met with in designing the motor, most manufacturers prefer the star-connected winding to the delta grouping. For the same operating voltage a star-connected winding requires only 58 per cent of the number of turns needed for the delta-connection and the same output.

Because of the larger number of turns in the coils of the delta-connected winding, less copper can be placed in a given size slot due to the extra amount of insulation on the small wire compared to the amount of copper. Coils made of a larger number of turns of small wire are less rigid mechanically than those made of a smaller number of turns of larger wire. For that reason the coils in a delta-connected winding will generally require more binding and bracing at the ends than those of a star-connected winding. It also requires more time to wind the coils with the smaller wire than with the larger, and the small wire costs more per pound.

Both types of connection are used, and it is a matter of which will best serve the designer's purposes. In many cases, all things considered, the delta-connected winding will prove to be the most economical and convenient to use, notwithstanding the claimed advantages of the star connection over the delta.

Why 350-hp. Diesel Engine Knocks with Less Load

Answers to the October Question

The Question

OUR 350-hp., 225-r.p.m., 3-cyl., 4-cycle, solid-injection diesel engine ran all right for two years while our load was heavier than at present. Now there is a bad knock, especially in the cylinder nearest the flywheel, and exhaust from that cylinder seems much hotter than from the others. We burn more fuel oil than when there was more load. We use metered city water for cooling and keep the water below 170 deg. F. as it leaves the engine, to avoid deposits from the hard water. Why doesn't the engine run as well as it did before? Why does it take more fuel? Should the pistons be taken out and cleaned as well as the exhaust valves? A. F. O.

Use Indicator Card

AS THE cylinder knock is accompanied by high exhaust temperature and excessive fuel consumption, the cause is probably early firing. Some fuel is getting past the fuel valve or injection nozzle during the exhaust, suction and compression portions of the cycle, and burning therefore commences in the cylinder before the proper firing position.

This early admission of the fuel may be caused by either a leaky fuel valve or injection nozzle, or by faulty timing of the fuel valve or fuel injection pump. The high temperature of the exhaust shows the necessity of overhauling the exhaust valve. The pistons should also be drawn and cleaned and the rings examined.

An ordinary indicator card will show a high pointed diagram for early firing, and a pull card will also show it clearly.

Brownsburg, P. Q. WM. FELL.

Use a Water Softener

A COOLING water outlet temperature for hard water of 170 deg. F. is far too high, because carbonates will settle out at lower temperatures and consequently scale up the jackets, which means trouble aplenty. An outlet temperature of not more than 120 deg. F. would be better, but soft water is to be preferred. The initial outlay for a water softener will soon be paid for by better performance of the unit.

After a running period of two years the engine is overdue for a good overhauling, even if the best fuel and lubricating oils have been used. My advice to A.F.O. is to secure an engineer who knows diesel engines.

Rochelle, Ill. MAX O. BUNGE.

Several Possible Causes

CAUSES of the difficulties encountered with this engine cannot be determined definitely from the information given, as there are a number of combinations which will give the same result. However, there is a most probable combination, which is described here.

As the engine operated over a considerable period and with a fairly heavy load, it may be assumed that the engine proper is not at fault. It is also assumed that the fuel oil used is the same as that which had previously proved satisfactory. The loading was reduced on this engine, and operation of a diesel at too light a load for any considerable time is likely to cause carbon to form in the combustion chamber. This carbon could cause the rings to stick, lowering the compression ratio and producing an overload condition, even though engine loading had been reduced.

If, in this case, the cylinder next to the flywheel should have a better com-

pression ratio due to the rings being in better condition, this cylinder would be overloaded and consequently would tend to knock.

It is also possible that, during the two years of operation, the exhaust valves (principal source of valve troubles) could have become poorer on the two cylinders furthest from the flywheel. This would also tend to allow the better cylinder to overload and pound.

In both cases, the resulting fuel economy would necessarily be poor, and the exhaust temperature of the overloaded cylinder would be higher.

The fact that the cooling water temperature was about 170 deg. F. suggests that the engine was overloaded in at least one cylinder. This temperature on the type of engine in question should never exceed 130 deg. F. and is best kept at 115-120 deg.

In the first case the pistons should be cleaned, and in the second the exhaust valves should be seated. It would be well to go over the entire engine after operating for the period stated.

Another highly probable cause for the trouble could be in the fuel nozzle. If the cylinder next to the flywheel is getting too much fuel because of a leaky nozzle or one having too great an opening, then that cylinder will overload and pound. The exhaust temperature will be greater and fuel economy below normal. The nozzle should be checked and cleaned every 30 days in any case.

KENNETH M. STOTT,
Inspector for The Hartford Steam Boiler Inspection & Insurance Co.
Chicago, Ill.

Maintenance Overdue; Try A Going-Over

IT IS hard to guess just what is the cause of the increased fuel consumption or the knock without knowing more about the conditions of operation. I infer from A.F.O.'s statement that he has not cleaned the pistons or valves, and it may be that other items of maintenance are a little overdue. If he will give the engine a thorough going-over and make all adjustments properly it will do as well as it did when new. The fact that it did run satisfactorily at one time is evidence that it will do so again if properly repaired.

To begin with, I would take some indicator cards and see if they didn't show the cause of the trouble. The compression might be low, or the timing and combustion might not be right. If the compression is low, it might be due to blow-by, leaky valves or worn bearings. If the engine is equipped with air cleaners, they may be clogged and the full amount of air may not be reaching the cylinder. Cleaning up the rings, valves and adjusting the clearance plates between the rod and the crank bearing will fix the compression.

A Question for Our Readers

CONDENSATE from our gravity heating system returns at a temperature of about 190 deg., due to faulty operation of some of the radiator traps. Before being discharged to the sewer, the condensate flows through a heat exchanger which lowers the temperature to about 100 deg. and preheats the water before delivery to the domestic hot-water heater. As long as the temperature of the condensate discharged to the sewer is this low, will there be enough saving in steam or improvement in the operation of the heating system to justify the expense of finding and repairing the radiator traps that are out of order? C. H. R.

Suitable answers from readers will be paid for if space is available for their publication.

The next thing I would do would be to check the timing. In two years it is possible for enough slack to accumulate in the gear, cams and rollers to cause the firing to be two or three degrees late. Improper firing will cause the exhaust temperature to increase. The adjustments to make will depend on the engine. If timing adjustments are not carefully checked every month or so it is possible for one of the cylinders to become overloaded while the others are not doing their part. Poor timing and combustion will cause hot exhaust temperatures and sometimes pronounced knocks. In checking over the work outlined above, any bearing trouble will be noticed and no doubt corrected.

My observation has been that all waters except rain water will deposit some scale in an engine. Most of them will deposit quite a bit of scale in two years with a temperature of 170 deg. F., and A.F.O. may have more scale in the engine than he thinks. Scale interrupts cooling, and poor cooling reduces lubrication and increases friction. Also, the heat must get out some way, and if the water doesn't remove its share, more will pass out with the exhaust gas.

R. C. DOHE,
Sup't., City Light & Water Dep't.
Tahlequah, Okla.

Check for Adjustment And Carbon Accumulation

THE accumulation of carbon in the cylinder and on the head of the piston will decrease the volume of the combustion chamber and raise the compression pressure enough to cause detonation. Since the engine has been in service for more than two years, there is a possibility that the rings are worn enough to allow some of the lubricating oil to get above the piston where it causes carbon deposit and reduction of clearance volume. It would be well to inspect the pistons and rings and, if necessary, to renew the rings. The pistons should be thoroughly cleaned, including the ring grooves.

In operating a solid-injection diesel, it should be remembered that the fuel valve adjustment is delicate and that it is easy to get these valves out of adjustment. When this happens either as a result of wear or for other reasons, each cylinder does not get its proper share of fuel. The fact that the engine is not any longer called upon to carry its full load may be responsible for maladjustments. When carrying full load, each cylinder must carry its share of the load or full load can not be maintained, but when only partial loads are being carried the engine may apparently be operating satisfactorily even though the load is not evenly distributed. The fact that one cylinder shows a higher exhaust temperature than the others would lead one to believe that it is getting more than its share of fuel, either because of faulty adjustment of the fuel valve or because of leakage of the valve. The remedy is obvious: Check the adjustment and make sure the valve closes tightly.

WALLACE H. MARTIN,
Dep't. Mech. Engrg., Oregon State Agricultural College.
Corvallis, Ore.

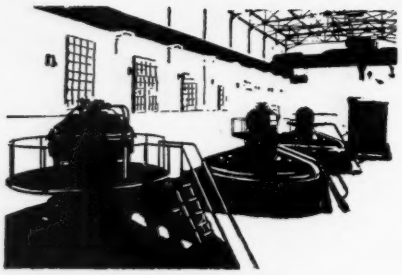
Thoroughly Run-Down Engine

A.F.O. is up against the same problem that countless numbers of other plants are—employment of person or persons incapable of holding up their end of the job. My first suggestion would be to employ a first-class diesel engineer to put the engine in first-class condition, and after it is in good condition keep him long enough to train the operator how to keep it that way.

It is mentioned that one cylinder seems to be hotter than the others. A pyrometer would do away with a guess; 170 deg. F. is too hot for hard water.

Pistons should be examined every year, and the alignment of the crankshaft should be checked at the same time. Exhaust valves should be cleaned and reground every three months. Indicator diagrams should be taken every two weeks to check up the fuel valve setting and compression—hand-pulled cards are satisfactory.

Any one or all of the following things could cause A.F.O.'s troubles: piston-rings stuck, exhaust valves stopped up with carbon, pistons fitting cylinder too tightly (due to being overheated at some time), main bearings out of line, piston-pin bearings worn, water jackets full of scale (making heat transfer too slow), late injection of fuel into cylinder, all of fuel not being burned (this may be in one or in all of the cylinders). It looks very much like a thoroughly run-down engine. H. W. STALNAKER.
Osceola, Ia.



IN THE POWER MART

(Further bulletin notices on page 330)

PROPELLER TURBINES—Eight-page bulletin No. 38 has been issued by Baldwin-Southwark Corp., Philadelphia, Pa., covering I. P. Morris propeller turbines having adjustable blades and fixed gates intended primarily for low heads. Included are power-efficiency curves, line drawings of the turbines and a "Chart of Characteristics for Standard Turbines" in two colors.

HOOVER DAM—Vol. 2 of a series of four booklets describing work at Hoover Dam by Ingersoll-Rand Co., 11 Broadway, New York, N. Y. This includes 40 pages and 85 illustrations.

TRASH RACK RAKE—S. Morgan Smith Co., York, Pa., has issued Bulletin No. 129 describing the Leonard trash rack rake for cleaning intakes for hydraulic and steam power and pumping stations.

WIRE-WOUND WELL STRAINERS—Bulletin 303 of A. D. Cook, Inc., Lawrence, Ind., describes "Cook" patent wire-wound well strainers. Bulletin 36, describing deep-well turbines, and Bulletin 29, describing cup-leathers with patent formed cup-leather spacing rings, have been revised.

WATER FILTER—Publication 1782, of Cochrane Corp., North Philadelphia P.O., Philadelphia, Pa., describes the Cochrane filter for swimming pools.

HIGH-PRESSURE HYDRAULIC PUMPS—12-page Bulletin No. 36 has been issued by Baldwin-Southwark Corp., Philadelphia, Pa., covering the company's line of high-pressure hydraulic pumps both horizontal and vertical. A detail description of construction together with tables of dimensions and capacities is included.

MULTI-STAGE CENTRIFUGAL PUMPS—Catalog B-5 of De Laval Steam Turbine Co., Trenton, N. J., describes multi-stage centrifugal pumps with single-suction impellers. These pumps have as many as seven stages in one casing, for heads up to or exceeding 1,600 lb. per sq.in., with necessary design variations to suit operating conditions.

SAND, GRAVEL & ROCK PUMPS—Bulletin No. 322 of Byron Jackson Co., Berkeley, Calif., describes the company's sand, gravel and rock pumps.

BOTTLE OILERS—Lunkenheimer Co., Cincinnati, Ohio, has issued a booklet on Lunkenheimer bottle oilers, their construction, operation and application.

ELECTRIC MINE EQUIPMENT — Electric Equipment for Mine Hoists is the subject of a new General Electric bulletin available from the company at Schenectady, N. Y., under No. GEA-1593.

LEVER-TYPE STRAIN GAGES—12-page Bulletin No. 37 has been issued by Baldwin-Southwark Corp., Philadelphia, Pa., covering the line of lever-type strain gages known as Huggenberger tensometers. Technical discussion of the instruments and methods of mounting and using and similar information is included.

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STOKER FIRING—Third edition of "Profits from Stoker Firing" includes basic principles of combustion, items to be considered in stoker selection and description of "Modern" coal burners. Modern Coal Burner Co., 3733 N. Lincoln Ave., Chicago, Ill.

COKE AND BY-PRODUCT TABLES—The Bureau of Mines of the Department of Commerce has issued "Coke and By-Product Tables, 1931," by F. G. Tryon and H. L. Bennit of the Coal Division, giving final statistics of production of by-product and beehive coke in 1931 based upon complete returns from the producers.

INDIRECT WATER HEATERS—Bell & Gossett Co., 3000 Wallace St., Chicago, Ill., has issued form 11A, describing B & G triple-duty indirect heaters for automatically fired hot-water heating boilers.

FUEL SAVINGS—Automatic coal scale is the subject of Bulletin 8132 of Richardson Scale Co., Clifton, N. J.

VARIABLE-SPEED MOTOR PULLEYS—Catalog V-200 is the first complete catalog of Reeves vari-speed motor pulleys manufactured by Reeves Pulley Co., Columbus, Ind. The catalog describes the design, operation and use of this control for light horsepower requirements. It gives complete engineering data, photographs of typical applications and convenient engineering information.

V-BELT DRIVES—Gates Rubber Co., Denver, Colo., has issued two revised sections for its catalog No. 3565, the first giving engineering data and general information, and the second stock sizes for immediate delivery on the company's line of rope drives.

GAS-FIRED IMMERSION HEATERS—Bulletin No. 21 of Steam & Combustion Co., 1559 Sheffield Ave., Chicago, Ill., gives illustrations, descriptions and specifications for "SteCom" gas-fired immersion heaters.

REFRACTORY MATERIALS — Specifications and methods of test for refractory materials and manual for interpretation of refractory test data has been prepared by Committee C-8 on Refractories of the American Society for Testing Materials. It brings together several A.S.T.M. standard specifications, methods of test and definitions. Copies at $0.50 each can be obtained from A.S.T.M. headquarters at 1315 Spruce St., Philadelphia, Pa.

SILICON-CARBIDE BRICK—General Refractories Co., Philadelphia, Pa., has available bulletin and folders on "Carbex" silicon-carbide brick describing in detail the characteristics of the brick and giving illustrations of its application for boiler and industrial furnaces.

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VACUUM REFRIGERATION—Foster Wheeler Corp., 165 Broadway, New York, N. Y., now has Bulletin W.J.-32-6 containing new developments in the design and application of vacuum refrigeration systems.

CONDENSING AND COOLING SECTIONS—The research dept. of the National Radiator Corp., Johnstown, Pa., has issued Bulletin CP-6, describing features of design and construction of the new "National" condensing and cooling sections.

TUBE COUPLINGS—Parker Appliance Co., 10320 Berea Rd., Cleveland, Ohio, has issued Catalog No. 34 describing "Parker Innerseal Fittings" which make up mechanically pressure tight before joints and copper pipes are soldered by means of a solder flux placed in the joint before it is closed.

SEAMLESS STEEL FITTINGS—The second issue of the booklet "Taylor Forge" treats in general the subject of welding and discusses particularly application of Taylor Forge seamless steel fittings. It is available from Taylor Forge & Pipe Works, P. O. Box 485, Chicago, Ill.

BRONZE-WELDING — Linde Air Products Co., 30 E. 42nd St., New York, N. Y., has issued a booklet on Oxweld No. 25 M. Bronze Patented Welding Rod for bronze welding of materials.

PIPE WELDING—Lefax, Inc., Philadelphia, Pa., has issued Order No. 32-60 on "Pipe Welding" compiled by Gas Products Association, Chicago, Ill., and prepared to fit the regular Lefax binder.

ADJUSTABLE ORIFICE VALVES — Bailey Meter Co., 1050 Ivanhoe Road, Cleveland, Ohio, has issued a folder, "A Hundred Orifices in One," describing the new Bailey adjustable orifice. Copies may be obtained from the company.

TEMPERATURE AND PRESSURE REGULATOR —Type E.T.D. combined temperature and pressure regulators are described in Bulletin No. 40 of the Spence Engineering Co., 110 E. 42nd St., New York, N. Y.

STEEL CHAINS—"Steel Chains for Power Transmission, Elevating and Conveying" is the subject of Book No. 1192 of the Link-Belt Co., Chicago and Indianapolis.

DIESEL ENGINES—The new "Caterpillar" diesel engine is described in this booklet available from the Caterpillar Tractor Co., Peoria, Ill.

GAS-ELECTRIC SETS—Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa., has issued 8-page illustrated bulletin, "Gas-Electric Sets for Every Application." These sets are designed for furnishing continuous or auxiliary power supply and for emergency service. Publication is C.1959.

DIESEL ENGINES—Superior Engine Co., Springfield, Ohio, has issued an Operator's Manual for "Superior" diesel engines.

GAS ENGINES — Worthington Pump & Machinery Corp., Worthington Ave. at Warren St., Harrison, N. J., has issued a number of new publications including the following: 6-page Bulletin S-550-S4 describing horizontal 4-cycle double-acting 30-in. stroke gas engines; 8-page Bulletin W-900-B12 describing improved cold water disk meters; 4-page Bulletin W-323-B1 describing centrifugal pumps arranged for automatic priming by means of a "Hytor" priming unit; 4-page Bulletin D-450-S12 describing vertical rotating shaft type drainage and irrigation pumps; 4-page Bulletin D-450-S9 covering deep-well pumps of the vertical rotating shaft-type up to 6 in.; 4-page Bulletin D-450-S10 covering 6-in., 8-in. and 10-in. wells; 4-page Bulletin D-450-S11 covering 12, 14, 16 and 20-in. wells, and Bulletin D-450-S2A describing vertical rotating shaft-type sump pump.

STORAGE TANK OIL HEATER—Griscom-Russell Co., 285 Madison Ave., New York, N. Y. Form 484 describes the new G-R G-fin storage tank oil heater.

CONVEYOR BELTS—"How Shall We Handle It?" is a recent publication of Diamond Rubber Co., Inc., Akron, Ohio, which is profusely illustrated with pictures showing conveyor belts in action under widely divergent conditions, and shows how economical handling of many types of materials has been answered in a number of plants.

LEATHER BELT DRIVES—Alexander Bros., Inc., Philadelphia, Pa., has issued a 32-page bulletin on "Modern Engineering Data on Leather Belt Drives," giving engineering information and price list.

INDUSTRIAL LIGHTING EQUIPMENT—Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa., has issued Catalog 219-A on industrial lighting equipment, including new units, low-priced industrial floodlights, Wemco reflectors and sockets. Catalog 219-B has also been issued describing commercial lighting equipment.

INDOOR CIRCUIT BREAKERS — "De-Ion Grid" indoor oil circuit breakers of Westinghouse Electric & Mfg. Co. are now described in Catalog C.1958, and outdoor-type circuit breakers are described in Bulletin C.1771-B.

TEXROPE DRIVES—A revised edition of Tex-Book price section No. 2960 covering standard Texrope drives, 50 to 350 hp., as well as general engineering information is now available from Allis-Chalmers Mfg. Co., Milwaukee, Wis. Center-distance tables have been added showing all possible combinations to eliminate calculations when selecting drives from standard sections.

WORM GEAR SPEED REDUCERS—Foote Bros. Gear & Machine Co., 215 N. Curtis St., Chicago, Ill., has revised No. 301 "Hygrade" catalog containing engineering information and technical data. New one is No. 302.

METAL-CLAD SWITCHGEAR—Type MI-6 metal-clad switchgear of General Electric Co., Schenectady, N. Y., is described in that company's Bulletin GEA-1661.

SOUNDING THE COAL PILE

From Traveling Crane

Using painted marks on crane and craneway, the coal yard is automatically divided into squares whose burden can be measured by "sounding" from the crane

▼

EVERY steam plant with outdoor coal storage faces an inventory problem. Both the engineer and the accounting department will want to know yearly—perhaps monthly—the amount of coal and money represented by the stored coal in the yard. This can be determined in two ways: first, by direct measurement; and, second, by adding to the amount in storage on a reference date the amount added since and subtracting from this the amount used. A properly run plant should employ both methods as a mutual check.

Since a direct measurement inventory cannot be made with high precision, the difference between one measurement of yard storage and another made soon after is hardly a safe measure of coal consumption during this period.

On the other hand, failure of the two records to check within a reasonable percentage over a long period (say one year) at once casts suspicion on the measurements of coal consumption or coal received. In this way serious dollar leaks may be disclosed.

If direct measurement of the coal pile is to be made at stated intervals, it is best to set up a systematic procedure with standard record forms. This procedure should be so standardized that it can easily be carried out by one of the engineer's assistants.

Problem Easy

Where the yard is served by a traveling crane (or gantry crane) the problem is easy. In half a day's work, more or less, the crane and the craneway can be graduated with paint marks so that the actual coal pile measurements become perfectly simple and direct.

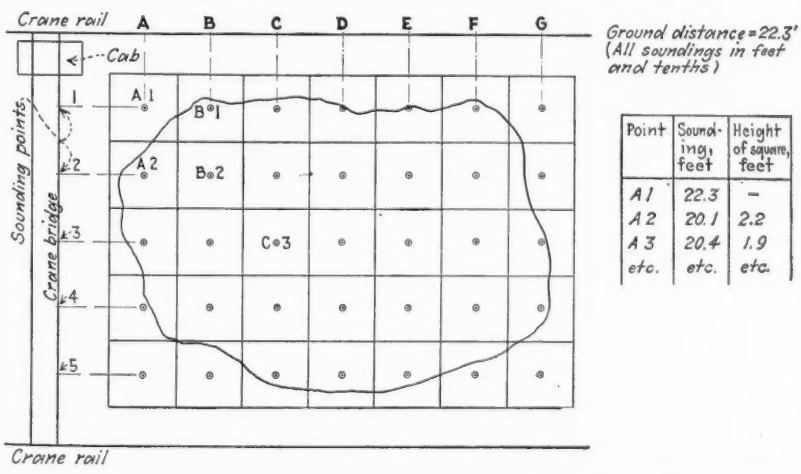
The first step is to lay out a rectangle between, and parallel with, the craneways and large enough to include the maximum coal pile. This rectangle may actually be laid out on the ground with four stakes, or it may be merely sketched on paper. The dimensions should be such that the rectangle will divide into even squares, preferably 10 ft. on a side.

Along the crane walkway, paint a series of marks 1, 2, 3, etc., in line with the centers of the corresponding squares. These spots should all be at the same level. In many cases they may be conveniently placed on the walkway hand rail.

Craneway Markings

Next, the graduations A, B, C, on the craneway are laid out with paint in the same manner, using some convenient point or mark on the end of the crane as a marker. Be certain to paint them at the *centers* of their respective squares.

If this marking has been done properly, the crane can be moved quickly to *C*, for example, whereupon a sounding tape dropped from the sounding point 3 on the crane will fall directly on the center of C3.



Ground distance = 22.3'
(All soundings in feet and tenths)

Point	Sounding, feet	Height of square, feet
A1	22.3	–
A2	20.1	2.2
A3	20.4	1.9
etc.	etc.	etc.

The crane and craneway are graduated as shown, with paint marks. Thus, when the crane is brought to C and the line dropped at 3, the weight will fall exactly on the center of C3

If the ground level is known, it is clear that the sounding tape can be used to measure the height at the center of the square column of coal C3. If the sloping coal surface is approximately flat over the area of the square the height computed will be very close to the true average height of the square column. Height times 100 will give the corresponding volume in cubic feet.

This, of course, does not hold true for the outside squares that are only partly covered. For example, square A4 in the sketch would show no coal at all. This error will not be important if the squares are fairly small in comparison with the total area covered by the coal, or it can be estimated and added to the total.

In applying this method, several time-saving cuts may be employed. First a tape may be employed reading in feet and tenths, which is much more convenient than feet and inches. Such graduations may be transferred in paint to the back of an ordinary tape with sufficient accuracy. If the ground is practically level, it will save additional time to have the zero of the tape at the marker on the walkway when the weight is on the ground. With this arrangement the tape will read directly the height of the coal column. All the measured heights can then be added together to give the total equivalent height of a single 10-ft. square column of coal. This can then be multiplied by the weight of a column 10-ft. square and 1 ft. high to give the total weight of the coal pile.

Uneven Ground

If the ground is uneven, a record form with one more column than illustrated is convenient. The ground distances are determined once for all, by measurement or estimation. They are filled in on the form, which may then be mimeographed. This form may be used directly by the man operating the sounding line.

For the weight used on the sounding line a blunt ended slug of iron is better than a plumb bob. A good shape is a cylinder of iron about 4 in. long and 3 in. in diameter with a ring bolt in the top. A larger weight or thinner line may be required in very windy locations or with high cranes. Do not fail to allow for the length of weight in sounding.

In estimating the ground level at points where the ground is always covered, an error may be introduced, but this will be a small constant error which will not affect the computed changes in storage from one measurement of the pile to the next.

SELECTING INSULATING VARNISHES

That Meet Service Requirements*

By R. H. ARNOLD and L. E. FROST
Westinghouse Electric & Manufacturing Co.

▼

THE dependability for which electrical apparatus is noted is due, in large measure, to the services performed by insulating varnishes. Not only are these materials important as insulators themselves, but they also serve to protect and preserve the insulating properties of other materials used as insulation. Most of the widely used insulators, such as cotton, paper, wood and asbestos, are excellent insulators when dry, but they absorb moisture readily and become more or less conducting. Varnishes and compounds are applied to practically all types of electrical windings to perform the multiple services of guardian and preservative. They protect the assembly from the effects of moisture, dirt and oil, besides giving the insulating materials the durability that is required under operating conditions.

Ratings of electrical apparatus are governed largely by the natural tendency of most insulating materials to grow old prematurely when exposed to high temperatures. In windings, heat generated in the inner parts must be carried to the surfaces and dissipated through the insulating coating. Thus the internal temperature depends largely on the heat conductivity of the insulation. A porous, air-filled insulation is inferior, for heat transfer, to one which is well filled and compacted. To bring about this filling and solidifying of insulation is a function of insulating varnishes.

The effect of high temperature upon insulation is a form of drying out that causes two kinds of impairment, first, embrittling which renders the insulation less capable of resisting destructive effects of vibration and of the stresses and abrasion due to alternate heating and cooling; secondly, a shrinkage in volume which tends to create looseness of parts and consequent chafing. Varnish is applied to retard the embrittling, and, by its cementing action, to prevent loosening of conductors and coils.

Safe Operating Temperatures

Safe operating temperatures for the two general classes of insulation are fixed by the A.I.E.E. Class "A" insulation is wholly organic, such as cotton and paper, and has a maximum temperature for continued operation of 90 deg. C. Insulation made up mainly of mica and asbestos, Class "B," has a rating of 110 deg. C. These temperatures are measured by placing a thermometer against the exterior of the windings and are, therefore, lower than the actual hot-spot temperatures.

Completely filling the interstices of a coil presents numerous difficulties. Varnish ordinarily consists of 45 to 55 per cent solids, the remainder being volatile solvent. When the coil is drained, after dipping, part of the varnish runs out, and of what remains, about 50 per cent goes out the ventilator of the baking oven. Obviously, a better filling varnish which can be used with less solvent is one of the things that insulation engineers are seeking. Solid compounds are now used for some applications where better filling is essential, but they possess certain objectionable features which limit their usefulness. These compounds require vacuum and pressure equipment to apply; they may flow out in service, due to overload; and they are almost certain to throw if applied to rotating windings. So called solventless varnishes are another attempted answer to the problem. They have filling properties similar to solid compounds, but they also require special equipment to apply. Their use has been confined to stationary parts because of difficulties in hardening them sufficiently to stand centrifugal forces that might throw them out.

Coil-Filling Varnishes

Varnishes used mainly for filling the interior of coils must be sufficiently flexible to withstand the expansion and contraction of the winding in service and should retain this flexibility with continued heating. Obviously, they should also be free from effect on enameled wire.

In addition to the treatment with a filling varnish or compound, most windings receive also a surface treatment of one or more applications of varnish. Here, the problems are not much different from those of ordinary coating varnishes. As with varnishes used for filling, a varnish that can be used with a minimum of solvent is to be preferred. The essential thing is to get a good "build" and a smooth coat. Good build is important because the coating must completely hide the tape covering of the coils in order to furnish the maximum protection. A varnish that will do this in the fewest number of dips, other things being equal, is the best varnish for the job. There is a great difference in varnishes in their ability to bake out to a smooth coating. A test of this property was made by applying two overlapping layers of untreated cotton tape to 1-ft. lengths of ½-in. iron pipe. The varnishes were first used without thinning, and three coats were applied, baking each coat. If the coating was wrinkled after the third bake the varnish was thinned and the test repeated. The best coating varnishes required no thinning, contained as high as 55 per cent solids, and gave a puncture voltage of from 9,000 to 10,000 volts. Some of the varnishes which had to be thinned to avoid wrinkling required six coats to attain a like film thickness and puncture voltage.

Varnishes for surface treatments are chosen with emphasis on such qualities as toughness of film, oil resistance, and long life under heat.

Much work has been done on methods of testing insulating varnishes to make proper selections for specific applications and to provide a check on uniformity. For the latter purpose the tests are adequate. There is some doubt, however, regarding certain of the tests when used for the selection of varnishes. It is sometimes found that varnishes selected by these tests do not perform as predicted when put into production. One case was recently reported to the Varnish Committee of the A.S.T.M. where the varnish which was worst by laboratory test was best in practical application and the one which was best in the tests was far down the list in actual use. Also, it is well known that varnishes which show up exceedingly well on tests do not always show the best performance when used to impregnate winding insulation.

Wire Enamels

The question of impregnating materials used with enameled wire is important. A large proportion of the enameled wires on the market will have the enamel seriously softened or removed altogether by treatment necessary to impregnate the coil. These materials usually are one of three types—asphalts applied in molten state by vacuum and pressure, varnishes with volatile thinners soaked into the coil and then set by baking, and varnish resins plasticized with castor oil or some similar material, applied by vacuum and pressure in the molten state.

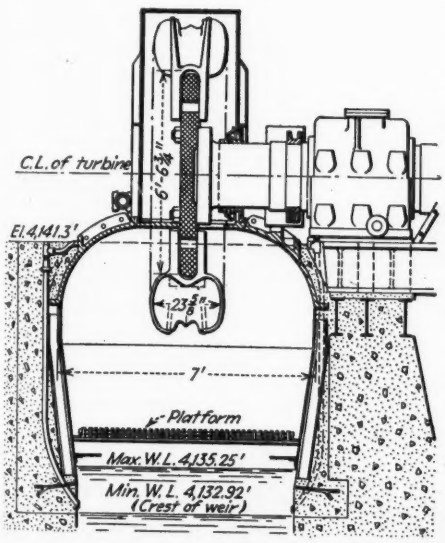
The evidence of failure in the coils is, of course, short circuits occurring between turns, either immediately after winding or after a time in service. With the modern, high-frequency testing outfits which will detect one shorted turn in ten thousand, the coil must be right to get by the inspector. These shorts are caused by bare spots on the wire, soft films cutting through due to the pressure of the winding, or in some cases a low-resistance film permitting enough leakage to indicate a short even though there is no actual contact.

*Abstract of a paper "Service Requirements of Insulating Varnish," presented before the American Chemical Society convention in Denver, Colo.

Stainless Steel Buckets on 17,000-Hp. Impulse Wheels

Four 17,000-hp. impulse wheels to operate at 428.5 r.p.m. under a 2,000-ft. head in the Shanan plant, Punjab, India, have buckets of stainless steel cast in pairs. Needles and orifices are also of stainless steel

WHAT are claimed to be the largest single-runner Pelton water-wheels built in England were completed recently. A feature of these wheels is the use of stainless steel for those parts most likely to be subjected to erosion and corrosion. These units, four in number, are to be installed in the Shanan plant on the Uhl River,



Cross-section through one of the wheels and its setting

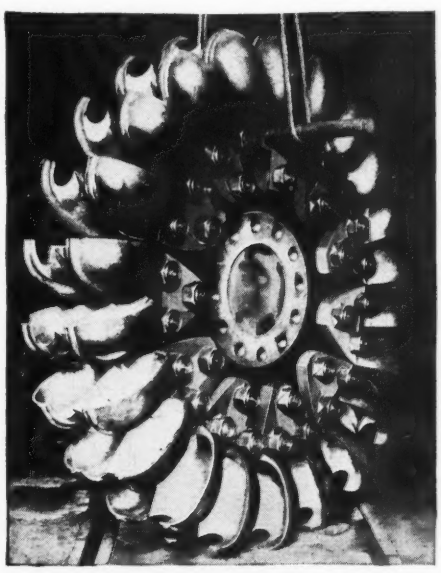
Punjab, India. According to *The Engineer* (London) each unit consists of a single runner with a single jet overhung on the end of the generator shaft, and is rated at 17,000 hp. when running at a normal speed of 428.5 r.p.m. under an effective head of 1,668 ft. The wheels will ultimately be worked under a head of 2,001 ft. when a dam in the river has been raised, but the output of the wheels will still be restricted to 17,000 hp.

Each wheel consists of a solid steel disk 6 ft. 6¾ in. in diameter, to which are bolted 22 buckets, as shown in the figures. These buckets are cast in pairs with lugs that embrace the disk, and each pair is held by three bolts. The reason for making the buckets in pairs and sharing the lugs is that if each bucket had its own lugs each lug would require two bolts, and there would not be sufficient room around the circumference of the disk to accommodate them.

The buckets are cast of stainless steel, and out of four sets of 22 buckets, only one defect was produced. This one was discarded on account of a blowhole, but served to provide test pieces. The tests showed a tensile breaking strength of 118,800 lb. per sq.in., a yield point of 79,200 lb. per sq.in. and an elongation of 22.9 per cent, with a reduction of area of 42 per cent. The buckets are carefully machined so that their lugs straddle the disk exactly, and are held in place by bolts with a slight taper. The nuts on the bolts are prevented from slacking back by folded-up washers and a small tack of electric welding.

The jet has a maximum diameter of 8 in. and comes from a forged stainless-steel orifice. The needle valve, which is used to control the jet, is of cast stainless steel with a forged stainless steel point, and is carried by a stainless-steel spindle, which works in a bronze bushing and is protected by a galvanized-steel-tube casing. The materials have been chosen to minimize electrolytic action.

Control of the turbine is by combined action of deflecting the jet away from the wheel, and regulation of flow by means of the needle valve, in such a manner that the pipe line is not subjected to severe water hammer. If the load is suddenly reduced, the jet is immediately deflected from the bucket, and the needle valve then gradually reduces the jet to the load requirements as the deflector comes back to its normal position. On an increase in load the needle valve increases the jet at a rate compatible with safety of the pipe line.



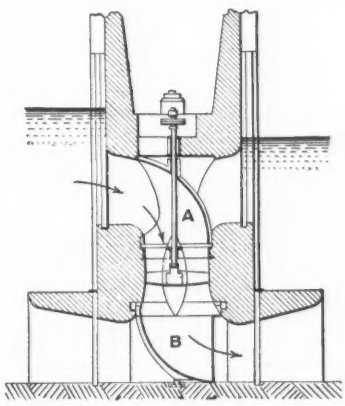
The buckets are cast in pairs and held to the disk by three bolts

Under the speed guarantees, regulations of the unit is to be such that if half load is suddenly thrown off the momentary rise in speed will not exceed 3½ per cent; for three-quarter load, 5¼ per cent, and if the full load of 17,000 hp. is suddenly lost, the rise in speed will not be more than 7 per cent. The guaranteed efficiency at 8,500-hp. load is 89 per cent, at three-quarter load, 90 per cent, and at full load, 89.5 per cent, which is unusually high for an impulse-type wheel.

●

Reversible Turbine Setting for Tidal-Power Plant

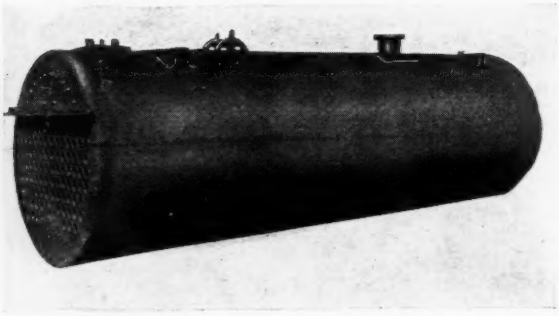
MANY suggestions have been made for tide-power plants, but the one reported in the June 24 number of *Engineering*, London, has elements that are novel. A patent has been applied for on this system by the English Electric Company, Ltd., and P. W. Seewer, London. This plant is similar to a

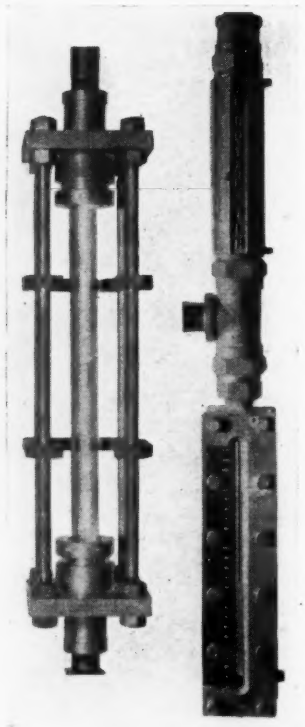


standard vertical hydro-electric installation except that the intake and discharge water passages are arranged so that they may accommodate flow in either direction.

The turbine is installed in the dam across the tidal basin. With rising tide the water level on the sea side of the dam rises above that in the tidal basin. Assume such a condition to be shown in the figure. The water will flow through the turbine as indicated by the curved arrows and will fill the tidal basin. With an outflowing tide the water level on the sea side of the dam will drop below that in the tidal basin. To operate the turbine under this condition, section *A* in the turbine intake and the draft-tube elbow *B* are rotated through 180 deg. When this has been done water can flow from the tidal basin through the turbine and draft tube to the sea. Sections *A* and *B*, it is proposed, may be used as valves thus dispensing with additional valves for shutting off the water.

WHAT'S NEW IN PLANT EQUIPMENT

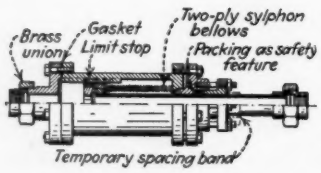




Welded Fire-Tube Boilers

Welded fire-tube boilers for high pressures and high ratings eliminate girth seam and fire crack difficulties. All boilers are made by electric welding, and physical tests are made of welded coupons attached to each end of the longitudinal seams of all boilers, all seams are X-rayed to prove soundness of welds, and boilers are stress-relieved in a large furnace to eliminate internal stresses. Thus the boilers meet the A.S.M.E. code and are insurable. Described in Bulletin HT-9.

Hedges-Walsh-Weidner Co., Chattanooga, Tenn.



Packless Expansion Joint

"Sylphon" packless expansion joint No. 111 uses packing merely as a safety feature to offset fears of those still skeptical about metal bellows expansion members. The packing does not function until a leak occurs within the joint. The metal bellows is two-ply, and limit stops allow a total travel of 1½ in. for expansion and contraction of 80 ft. of brass pipe or 120 ft. of wrought iron pipe with variations of 20 to 180 deg. F. Pressures up to 150 lb. per sq.in. may be carried. Construction is largely brass.

Fulton Sylphon Co., Knoxville, Tenn.

Indicating Flow Meter

The "Rotameter," a non-recording instrument designed to show rates of flow in pipe lines carrying fluid or gases, consists of a simple frame on which are inlet and outlet connections and on which is mounted a vertical, transparent tube having a tapered bore with small diameter at the bottom. This tube is protected by a guard and has inside it a top-shaped float. Special shape of float keeps it in center of stream to produce frictionless action. Annular space between float and tube increases as float is carried up by increasing flow thus providing direct relationship and giving readings correct within capacity ranges from 100 per cent of full flow down to 10 per cent to an accuracy of 1 per cent. Several variations of the simple unit are available. Illustrated are the simple Rotameter and a 1-in. extension type using the same operating principle except that tapered glass tube has been replaced by tapered metal tube, and an extension rod has been attached to the float. This gives flow indications in the glass-windowed chamber located below the tapered measuring tube.

Schutte & Koerting Co., 12th & Thompson Sts., Philadelphia, Pa.

Heat Reflection Brick

EF brick, designed for direct exposure and heat reflection, allows quick heating and eliminates heat storage, particularly in electric furnace or any type furnace construction where abrasion from movement of ware or impingement of gaseous or oil fuel is not a major factor. Adaptable for flat arch construction, and has sufficient strength for structural purposes or for hanging electric elements on wall, stands quick heating and cooling with spalling. Thinner wall has higher heat reflection. Comes in machine sizes but may be made in special large sizes and shapes.

Armstrong Cork & Insulation Co., Lancaster, Pa.

Improved Horizontal Duplex Steam Pumps for Oil

Designed and fitted for handling cold or hot oils and gasoline, this improved line of horizontal steam pumps is built in three types—valve plate, turret and pot valve. Stainless steel drop-forged valve service and submerged-piston construction used. Valve plate type units handle cold oils up to 300 deg. F., and 5,000 S.U.S. viscosity. For hot oil service, above 350 deg. F., the pumps have water-cooled stuffing boxes and special liquid ends. Capacities from 40 to 320 g.p.m. at pressures to 150 lb. per sq.in., and from 20 to 240 g.p.m. for pressures up to 350 lb. per sq.in. Turret-type pumps are available for cold oil service up to 150 to 840 g.p.m. for pressures to 75 lb. per sq.in., and with capacities of 100 to 500 g.p.m. for pressures up to 200 lb. per sq.in. Pot-valve pumps come in two designs: For pressures up to 750 lb. per sq.in. with capacities of 35 to 350 g.p.m., they have poppet valve service and cast-steel liquid ends with removable Ni-Resist liners. For pressures to 500 lb. per sq.in. and capacities of 140 to 1,800 g.p.m., cylinders are cast steel.

Worthington Pump & Machinery Corp., Harrison, N. J.

Insulating & Cooling Medium for Electric Equipment

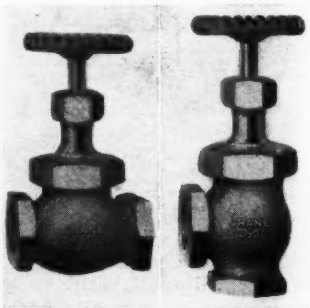
"Pyranol," a synthetic liquid insulator, claimed to combine advantages of mineral oil as an insulating and cooling medium for electrical equipment but also is non-inflammable and non-explosive. Composition varies for different purposes, all being synthetic organic dielectrics. Apparatus must be designed especially for its use. Liquid is chemically stable and resists oxidation. It separates from water twice as fast as does mineral oil. Viscosity and freezing point can be varied to suit conditions. It is clear in color, has Saybolt viscosity of 4 sec. (37.8 deg. C), pour point of minus 30 deg. C., and dielectric constant of 5.

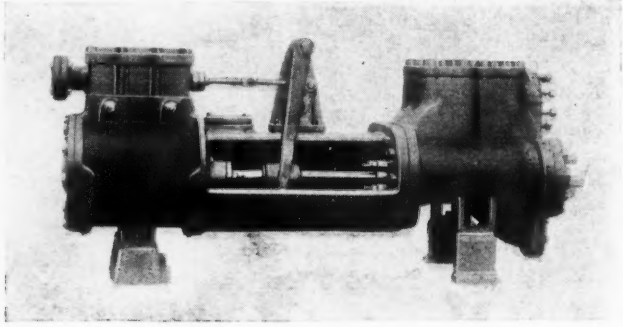
General Electric Co., Schenectady, N. Y.

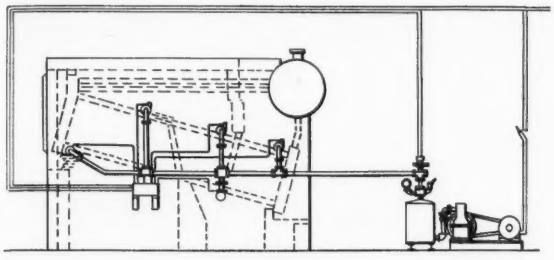
Globe and Angle Valves

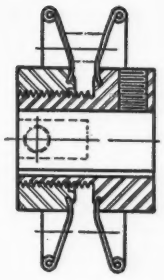
These additions to the Crane series of globe and angle valves with plug-type seats and disks have brass union bonnets and are for 250 lb. steam service. No. 212-P for globe and No. 214-P for angle are made in sizes from ¼ to 3 in. Plug-type disk provides large area of contact,, resistance to wire drawing and tends to overcome foreign matter lodging on seating surfaces. Plug-type valves provide accurate regulation for throttle valves also.

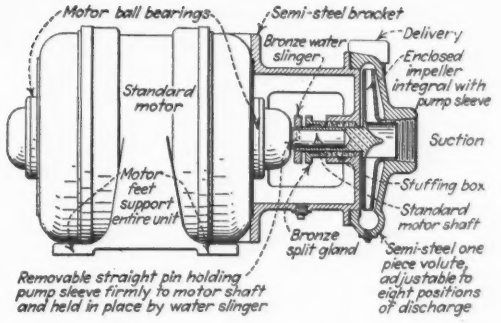
Crane Co., 836 S. Michigan Ave., Chicago, Ill.

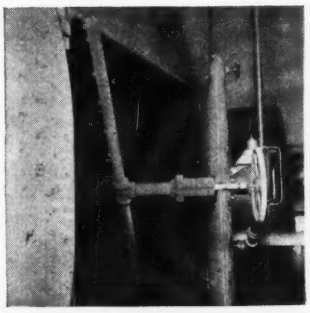


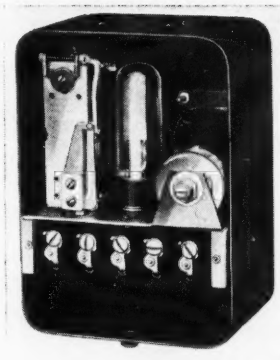


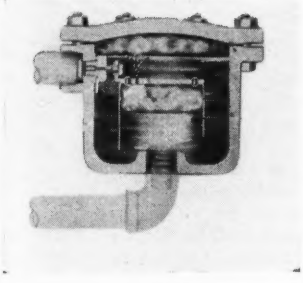





Motor ball bearings
Semi-steel bracket
Bronze water slinger
Delivery
Enclosed impeller integral with pump sleeve
Standard motor
Suction
Motor feet support entire unit
Stuffing box
Standard motor shaft
Bronze split gland
Semi-steel one piece volute, adjustable to eight positions of discharge
Removable straight pin holding pump sleeve firmly to motor shaft and held in place by water slinger







Soot Blower System

"Diamond" Air-Puff Soot Blower Systems are available for fire-tube and water-tube boilers. Fire tube, (left) known as "A-1," consist of a motor-driven compressor, air storage tank, pressure-actuated control valve, pilot valve, diaphragm member with the pilot valve, a blower arm, piston, and gear to rotate the blower arm and connecting pipe, valves, fittings and wiring for each boiler. A-2 System (top) for water-tube units consists of motor-driven compressors, storage tanks, pressure-actuated switch, and a controller with switch, electrical interrupter for timing duration of each blow, an air control valve, soot blower units, and connecting pipe, valves, fittings and wiring for each boiler.

Diamond Power Specialty Corp., Detroit, Mich.

Midget Photoelectric Relay

Applicable to installations where practically complete interception of the light beam is made, since changes of light intensity of at least 50 per cent are necessary for successful operation, this Midget photoelectric relay will handle directly the usual types of magnetic counters and will operate on light impulses of 1/15 of a second duration. Designated as CR7505-K1, it consists of a phototube, Pliotron amplifying tube, sensitive relay, adjustable potentiometer, and associated apparatus, all mounted on a steel base. A drawn shell inclosing case is provided.

General Electric Co., Schenectady, N. Y.

Inverted Open-Float Steam Traps

These small, efficient steam traps claimed simple in operation. Condensate flows upward into trap until body is full. Air and non-condensable gases entering trap pass through small vent hole at float top and collect at top of body. Inverted float is not buoyant so long as steam does not enter, therefore remains at bottom of body to hold valve open and allow condensate and air to be discharged continuously. When condensate flow stops, steam enters trap and displaces water in the float, which becomes buoyant and rises, thus closing valve and stopping discharge. Available in sizes of ½, ¾ and 1 in. for pressures to 150 lb.

Crane Co., 836 S. Michigan Ave., Chicago, Ill.

Cork Covering

This improved-type cork covering for cold pipes is 11 per cent more efficient than present standard cork covering because of lower density achieved by a new process of manufacture which knits cork granules more closely together. New covering is much more uniform than old. Has smoother inside surface and therefore fits more snugly in place with no possibility of moisture-attracting air spaces.

Armstrong Cork & Insulation Co., Lancaster, Pa.

Variable Pitch-Diameter Steel Sheave

Developed originally to meet demands for a variable-speed sheave on small fans and blowers for air-conditioning units but applicable to general service, this line of Texsteel sheaves obtains variable diameter by adjusting the two bevel plates shown. Standard sheaves already developed vary through a range of approximately 1 in. in diameter. Threaded portion of hub is provided with flat surfaces and locked in place by setscrew. Speed variations of 35 per cent.

Allis-Chalmers Mfg. Co., Milwaukee, Wis.

Sealed Corkboard

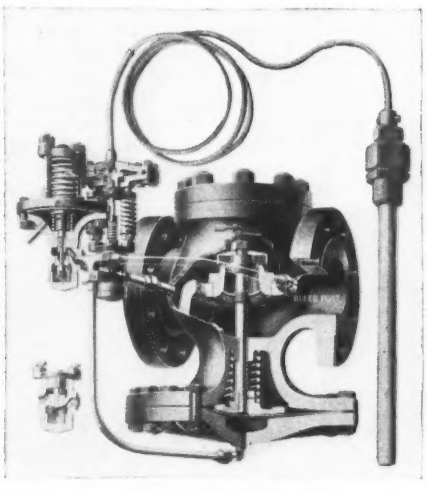
Super-service corkboard for cold storage rooms is coated on both faces at the factory with a special mastic compound applied mechanically under pressure. It is said to possess 15 per cent greater insulating efficiency than standard corkboard.

Armstrong Cork & Insulation Co., Lancaster, Pa.

Combined Temperature and Pressure Regulator

Type ETD Spence combined temperature and pressure regulator operates on steam pressures above 1 lb. Shuts tight when desired temperature is reached. Being pilot-operated, it will open wide or close tight on less than 2 deg. F., change in temperature. Does not require separate reducing valve. Thermostat cannot be injured by overheating. Over 100 deg. F. range. Equipped with Seco metal seats and Spence balanced metal diaphragms. Pilot-operated, single-seat end regulators with interchangeable pilots in all sizes ⅜ to 12 in. inclusive.

Spence Engineer-Co., Inc., 110 E. 42nd St., New York, N. Y.



Motored Centrifugal Pumps

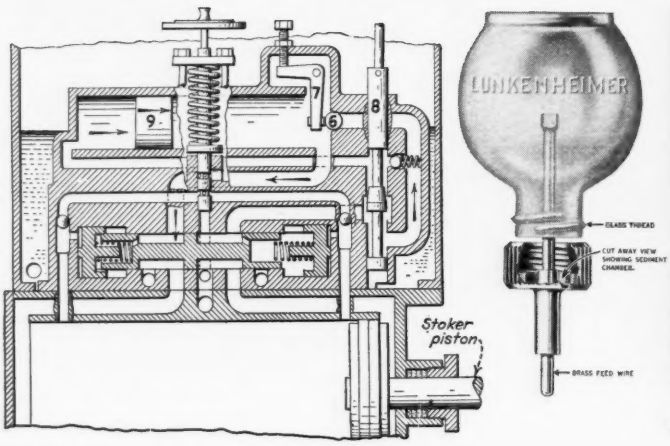
Type MUE (end suction) and MUI (inside suction) single-stage, single-suction, centrifugal pump motor units are a combination of centrifugal pump integral with its driving motor in a self-contained assembly. Built for capacities from 5 to 450 gal. per min. at heads as high as 120 ft. Unit provides exceptional flexibility. Motors ranging from ⅛ to 10 hp. are adaptable, operating at speeds of 1,750 and 3,500 r.p.m. Various sizes of discharge available from 1 to 3 in.

American Steam Pump Co., Battle Creek, Mich.

High Temperature Paint

Produced in various colors including green, black, red, gray and white, this high-temperature paint is recommended for coating furnace equipment or metal in places where intense heat is encountered. Known as Laclede C-10, and can be used in locomotive fronts, locomotive fire boxes, rotary kilns, hot air furnace equipment, etc., including boiler breechings, boiler fronts, exhaust fans, open hearth doors, coke oven doors, etc. Most refractory paint withstands 1,800 deg. F. Colors, including green, gray, red and black, withstand from 1,000 to 1,400 deg. F. Available in 1-qt., 1-gal. and 5-gal. cans and in 30-gal. and 50-gal. drums.

Laclede-Christy Clay Products Co., St. Louis, Mo.



Variable-Feed Control for Stokers

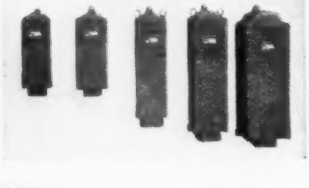
Stott hydraulic stokers, formerly attaining speed reduction by means of oil bypassing a needle valve, now have variable feed control. This is accomplished by causing the piston to "rest" for a definite interval after each complete out-and-in stroke. Length of this interval can be changed at will to give any desired rate of feed from full feed to as little as 1 or 2 per cent of full, yet action is positive and exact. Rate of operation is controlled by plunger and taper plug *8* which allows oil to flow past taper and eventually to force piston *9* against bell crank *7* which pushes ball valve *6* against its seat. This stops bypass of the oil, ends the time interval, and causes the oil to move the stoker piston. Adjustment of bell crank *7* provides control over ball valve *6* to create the desired limited back pressure which causes flow around the tapered control plug.

Stoker Division, Stott Briquet Co., Inc., St. Paul, Minn.

Capacitor Transformers

Capacitor transformers for correcting low power factor in existing luminous-tube sign installations supplement the present G.E. line of high power factor luminous-tube transformers. New unit consists of capacitor assembled with air-cooled auto transformer which steps up supply voltage to a value permitting most economical capacitor design. Capacitor transformer is connected directly across primary supply line and can be used to correct p.f. of a group of signs.

General Electric Co., Schenectady, N. Y.



Bottle Oiler

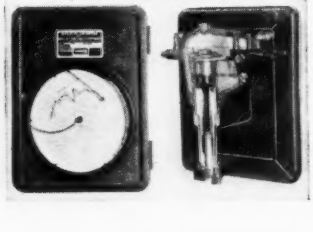
This oiler is made up of three major parts—glass bottle with threaded neck, bronze base with integral sleeve-type shank, and brass feed wire. Thick resilient cork washer seals joint between bottle and base. Oiler is entirely automatic in operation, feeding only when shaft is in motion thus avoiding oil wastage and providing correct amount of oil for bearing. Booklet 532 gives details.

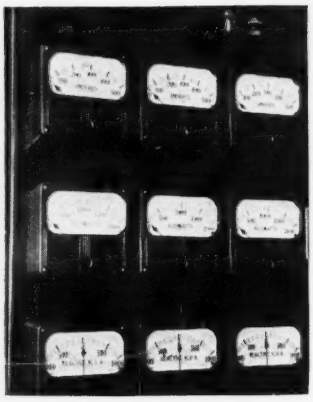
Lunkenheimer Co., Cincinnati, Ohio.

Fluid Meters

Three general combinations of the fluid meter for measurement of steam, water, gases, and other fluids are available: indicating and integrating; recording and integrating; indicating, recording, and integrating. Illustrated is the recording and integrating fluid meter best suited to the majority of installations. Record is made in lb. per hr., gal. per min, or any other desired units on a 12-in. diameter, 24-hr. chart. Flow graduations throughout are uniformly spaced. Sectional view shows flow mechanism which is operated by difference in pressure produced between inlet and outlet side of orifice or other primary element inserted in pipe line. Cases are arranged to permit mounting either on surface of a wall or panel, or flush on a panel. It can be used with any commercial operating pressure. The case is moisture and dust-proof. No moving parts which require oiling or greasing. Synchronous motor drive for clock.

Bailey Meter Co., 1050 Ivanhoe Road, Cleveland, Ohio.





Square-Case Instruments

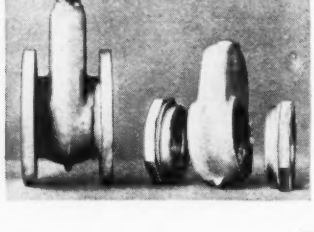
Properly-proportioned square cases to utilize a minimum of switchboard space feature the H line of instruments, including ammeters, milliammeters, voltmeters, milli-voltmeters, single- and polyphase power factor meters, frequency meters, and synchroscopes. Both a.c. and d.c. instruments are intended for service on large switchboards of steel, ebony asbestos, or slate. All have small size, long clearly-marked scales and greater overload capacity. Base is heavy-gage drawn steel with knockouts. Cover plate also of drawn steel.

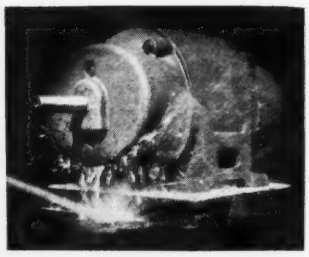
Westinghouse Electric & Mfg. Co., Newark, N. J.

Improved Gate Valve

Radical departure from conventional design has decreased weight, provided greater simplicity and interchangeability in this gate valve. Bronze disk is installed through flow passage, doing away entirely with bolted or threaded bonnet. Two sets of opposed threads operate to lift the disk twice as fast as the stem and with half as many turns. Disk is of self-aligning type, and seats are integral with the flanged or threaded ends. Lapping of seats is easily accomplished. Valve very light; 2½-in. size weighs 6 lb. in aluminum and 13 lb. in bronze. A variety of connection arrangements are available, including both ends flanged, both threaded with either male or female threads; one end flanged, the other threaded, etc.

Shand & Jurs Co., 917 Carlton, Berkeley, Calif.





Splash-Proof Motor

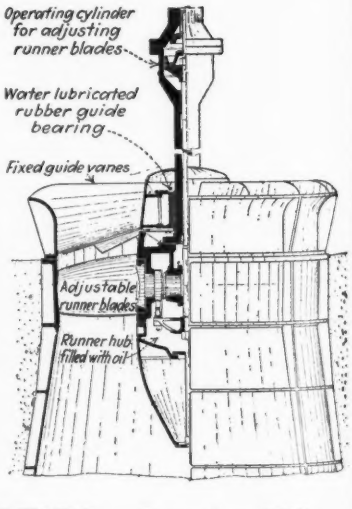
Adequately ventilated and built in same dimensions as standard open motors but designed to prevent entrance of water splashed with terrific pressure from any angle, this motor uses double baffle in an elliptical-shaped air passage in each endbell to give protection. Thus water splashed into the air openings is trapped and drained. Shaft guard breaks the force of a stream directed along shaft extension and prevents water from entering bearing chamber. Illustration shows motor operating at 1,800 r.p.m. and subjected to direct streams of water.

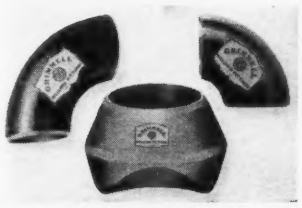
The Louis Allis Co., Milwaukee, Wis.

Propeller Turbines

I. P. Morris propeller turbines for low heads have adjustable runner blades, fixed guide vanes, high part-load efficiency, high speed, no operating mechanisms except runner blades, and are automatic. They are claimed best for small and medium-size hydro-electric or power plants with operating heads below 60 ft., for energy producing plants with variable water flow, for automatic operation, and securing from available water a high percentage of theoretical power. Illustrated is a typical cross-section with runner blades adjusted by an oil pressure cylinder built as part of the turbine shaft and with oil connections running through generator shaft.

Baldwin-Southwark Corp., I. P. Morris division, Philadelphia, Pa.


Operating cylinder for adjusting runner blades
Water lubricated rubber guide bearing
Fixed guide vanes
Adjustable runner blades
Runner hub filled with oil



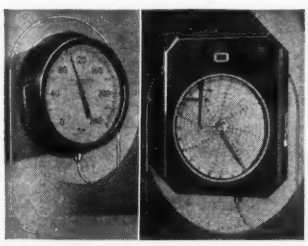
Welding Fittings

Grinnell welding outlets and threaded outlets are stock fittings designed for pipe welding to make tees, side outlet tees, crosses, etc., under practically all pressures and services. Threaded types are used principally for low-pressure heating systems, radiator outlets, branch lines, etc. Heavy external reinforcements provide strength and dissipate excess heat when welding, preventing shrinkage and distortion. Bases are shaped to fit the pipe and to provide funnel-shaped inlets to reduce friction.

Grinnell Co., Inc., 277 W. Exchange St., Providence, R. I.

Rectangular-Case Recording Thermometer

Available in both flush- and surface-mounted styles, new Taylor recording thermometers (right) have cast aluminum cases finished in black with chromium trim. Cases are moisture and dust-proof. Mercury, gas or vapor-actuated



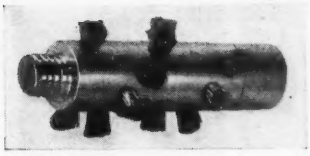
types are available in this design and also in dial pressure gages and thermometers (left). Heat-treated, chromium-plated, alloy steel movements can be obtained if desired for use under vibration. Either face or flush mounting. Embody new apparatus tubing, a compensated-type capillary with microscopically uniform bore.

Taylor Instrument Companies, Rochester, N. Y.

Porcelain Enamel Surfaces for Turbine Pumps

Application of porcelain similar to that used on plumbing materials for coating impellers or runners and bowls of deep-well turbine pumps is said to increase pump efficiency approximately 5 per cent and to be completely acid-resistant and resistant to sand abrasion also.

Johnston Pump Co., 2324 E. 49th St., Los Angeles, Calif.



Tube-Cleaning Brush

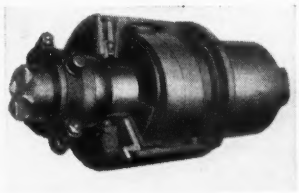
"Tubrush" tube-cleaning brushes have 18 tufts of bristles, each containing 133 wires of heat-treated steel, laid and crimped, and presenting 2,400 cutting edges. Bristles are self-centering and are straightline type, not bent or sewed. Can be renewed at factory. Made from ½-in. up to fit flexible-shaft equipment, and for hand punching. Reversible end cap.

Vroom Rotary Packing Corp., 755 South St., Waltham, Mass.

Duplex Ball Bearings

CD duplex double angular contact ball bearings provide a bearing of high thrust carrying capacity in either direction and with a width the same as the standard single row ball bearing. Light, medium and heavy metric series. Should be used only where thrust load exceeds radial load

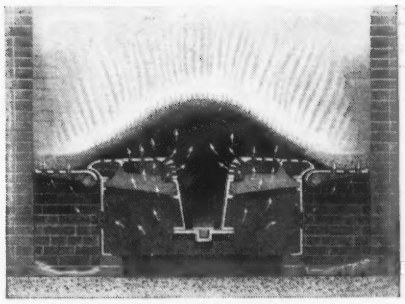
Norma-Hoffmann Bearings Corp., Stamford, Conn.



Disk-Actuated Spiral Friction Cut-Off Coupling

Compact and suitable as a drive between gas engines or motors and pumps, etc. Small diameter and shaft space requirements, high-speed operation, power transmission in ratio to speed, full enclosure, dust-proof construction, smooth exterior, single-point adjustment, and availability with either dry or lubricated friction surfaces Driving and driven shafts are held in line by ball guide bearing. Driving mechanism consists of spiral band contracting on a driving hub, band being actuated by flat asbestos-faced friction disk. Power is transmitted by spiral band, friction disk only contracts spiral. Shifter sleeve cone type. Three sizes, transmitting 3, 10 or 18 hp. Company also manufactures similar pulley clutch.

Kinney Mfg. Co., 3541 Washington St., Boston, Mass.



Full Underfeed Stoker

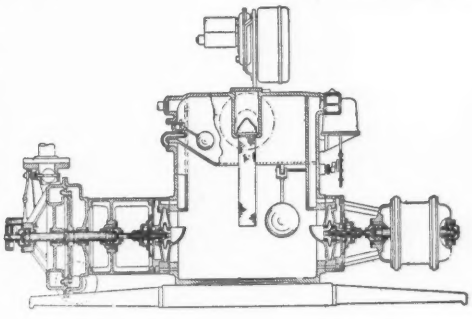
Detroit "LoStoker" is arranged for feed only when needed, being entirely automatic in control. Full underfeed principle introduces fuel by plunger feed below burning zone. Side cleaning preceded by air admission from air chamber to dumping grates in order to burn out combustible is followed by a simple turn of the dump lever to discharge ash. Ash removed through front door. Few setting alterations are required to adapt stoker to boilers already set. Illustration shows fuel and air distribution.

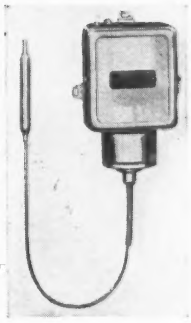
Detroit Stoker Co., Detroit.

Pump for Vacuum Heating Systems

For vacuum heating systems, the well-known Jennings vacuum pump is driven by a vapor turbine taking steam from the main heating line, exhausting it back to the heating system and operating on a 2½-lb. pressure differential. Incorporated is a complete electrically-operated standby unit with full automatic control. With this arrangement the capacity of both pumps can be utilized under peak load conditions, as the electrically-driven unit will automatically cut in at any time when steam supply is insufficient to operate the turbine. An installation is made in combination with a vapor turbine valve, which constantly maintains a pressure differential of 2½ lb. between the inlet and exhaust of the turbine. With this differential maintained the turbine will operate whether the heating system is under low-pressure or under a vacuum.

Nash Engineering Co., 166 Wilson Rd., South Norwalk, Conn.





Refrigeration Temperature Control

Minneapolis-Honeywell refrigeration temperature control Type 414-1 is suitable for commercial installations, either air temperature, brine or liquid systems. Control has visible scales with locking provision. The bulb-type unit is designed to provide remote control where it is not practical to place a thermostat.

Minneapolis-Honeywell Regulator Co., Minneapolis, Minn.

Corrosion Preventive

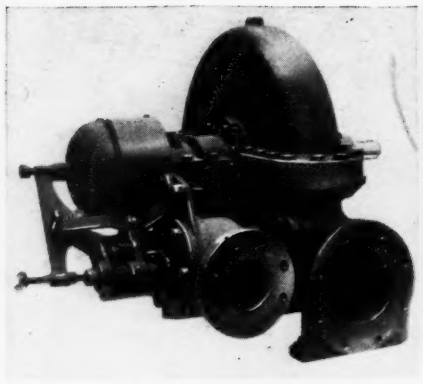
A chemical formula for controlling corrosion and eliminating scale and rust from hot water lines and heaters acts by combining directly with oxygen to form a stable compound thus removing oxygen as a factor in corrosion. The material, "H-O-H" does not coat piping.

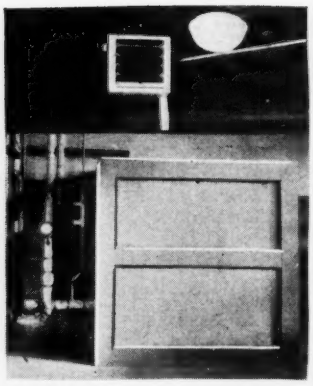
D. W. Herring & Co., 565 W. Washington Blvd., Chicago, Ill.

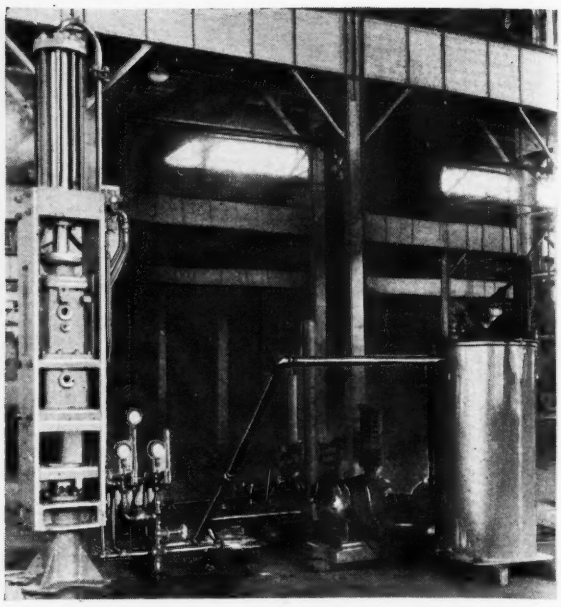
Metal Spray Gun

Capable of spraying lead, tin, zinc, aluminum, bronze, stainless steel, Monel, cold rolled and Norway iron on all materials, this "Metalspray" gun is now sold on Pacific Coast by De Laval Pacific Co., 61 Beale St., San Francisco. Unit consists of air turbine supplying power through reduction gears to two knurled wheels which feed metal wires into oxy-acetylene flame. Flame melts wire, air blast atomizes and impacts spray against any surface desired. Coatings of any desired thickness obtained. Nozzle design is simplified, capacity increased, and feed visible.

Metal Spray Co., Los Angeles, Calif.







Mechanical-Drive Steam Turbine

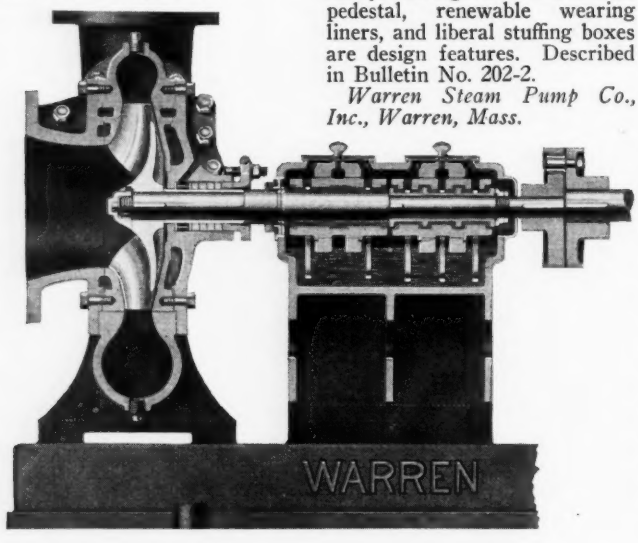
A new mechanical-drive non-condensing steam turbine for driving centrifugal pumps, fans and other rotating equipment at speeds from 1,200 to 4,000 r.p.m., is available up to 250 hp. under suitable steam conditions. The unit is single-stage, with two rows of revolving buckets. The wheel casing is split horizontally to allow access to internal parts, and the steam and exhaust pipes are connected to the lower half. Centrifugal governor, with weights pivoting on knife edges, operates with little friction and provides proper speed regulation. Independent emergency governor included.

General Electric Co., Schenectady, N. Y.

Differential Pressure Controllers

Series B and C differential pressure controllers have been added to the "Mercon" line. Series B have differentials adjustable manually at all times to any value to permit a smaller level regulator to be employed with equal capacity and greater flexibility. Series C units have differential automatically controlled to vary as square of steam demand. This results in rate of boiler feeding being almost synchronized with load.

Mercon Regulator Co., 1 La Salle St., Chicago, Ill.



Convector Cooling Unit

These overhead-type convector coolers have adjustable louvers in the housing to control elevation of air leaving the unit and avoid drafts. Suspended from ceiling or wall, they can be used with ice, mechanical refrigeration or tap water. Construction consists of an outer shell insulated from the chassis frame by cork, a radiator core and a fan and motor rubber mounted. The convector, with entering air at 80 deg. and 60 per cent relative humidity and 40-deg. water, has a cooling capacity of about 120 lb. ice melted per hour at medium fan speed. Capacity adjustable. Illustration shows, at top, installation in an office, and lower, the ice melting tank as installed in the basement.

McCord Radiator & Mfg. Co., Detroit, Mich.

Stock Pumps

Primarily for handling pulp and paper stock, this centrifugal pump is adaptable for handling other liquids having solids in suspension. Casings and front and back heads are split diagonally on pumps of 3-in. size and above to permit removal of rotating member and linings without disturbing piping. Illustrated is the pump arranged for direct drive. Self-cleaning impellers used may be varied to suit conditions. Heavy shaft and heavy bearings with substantial pedestal, renewable wearing liners, and liberal stuffing boxes are design features. Described in Bulletin No. 202-2.

Warren Steam Pump Co., Inc., Warren, Mass.

Solid CO_2 Press

A capacity of 62 tons, making a cake of solid CO_2 10 x 10 x 10 in., weighing about 50 lb., this press is unusual in that structural steel construction and welding are used throughout. The unit, self-contained, is supplied with water by motor-driven centrifugal pump at 250-lb. pressure, and a reciprocating hydraulic intensifier which is in effect a water-driven hydraulic pump. Water from the centrifugal at 215 lb. operates this pump to provide water at about 1,800 lb. per sq.in. The carbon-dioxide coming to the presses is under a pressure of about 1,400 lb. per sq.in., and somewhat below zero F. Operated by "Hylo" hydraulic power unit.

Southwark Foundry & Machine Co., 400 Washington Ave., Philadelphia, Pa.

Flow Controllers

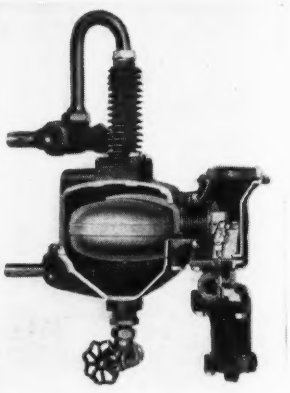
Regulators for maintaining proportional flow of liquids where the two liquids do not mix, or, if mixing, may do so at process points remote from the point of desired control have been added to the line of flow controllers under the "Mercon" trade mark. Former items include: constant flow regulators, flow limiting regulators and proportioning regulators for more general applications involving fluid mixing.

Mercon Regulator Co., 1 La Salle St., Chicago, Ill.

Water Feeder for Small Boilers

No. 37 "Safety" water feeder for boilers under 2,500-ft. capacity, follows the company's line of 30 series heaters, and also has quick hook-up features. Quick hook-up is accomplished by the brass nipple at left into the body of the feeder, and the adjustable goose-neck equipped with union and brass nipple for top connection. The unit is installed by inserting in gage glass position on boiler. When water level in boiler gets below 1 in. in the glass, it permits float to drop, thereby operating stainless steel valve through two sylphon bellows, permitting water to enter the boiler. The feature is a cool feed valve operating below 114 deg.

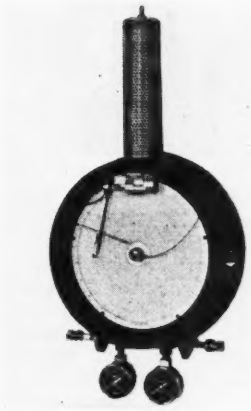
McDonnell & Miller, Wrigley Building, Chicago, Ill.



Transmission Belting

"Highflex Junior" belting is built up of a greater number of plies of a specially woven fabric in widths 6 in. and under, rubber impregnated. Special cement, tie gum and automatically controlled portable electric vulcanizers, together with the necessary template and hand tools are provided for permitting user to make endless belts in his own plant. All equipment portable. Vulcanizer made by James C. Heintz Co., Cleveland.

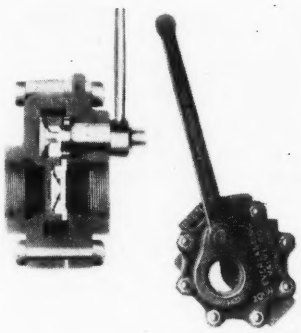
B. F. Goodrich Rubber Co., Akron, Ohio.



Relative Humidity Recorder

Relative humidity can be read directly, without calculation, from this recorder. It is simple and durable, especially for air conditioning service. It is portable, and is entirely self-contained. It employs a specially developed membrane calibrated so that relative humidity is recorded directly in per cent. Ten-inch case, seven-day or 24-hr. clock movement. Humidity controller also available, which maintains humidity by automatically controlling spray heads either through an air or water valve. Controller shown.

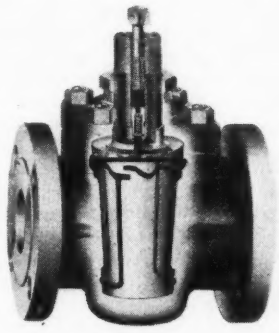
Foxboro Co., Foxboro, Mass.



Improved Quick-Opening Valve

Model W "Everlasting" valve retains the principle of passing a disk over the outlet port of the valve to effect a seal, although both disk and post spring are now cone instead of cylindrical units. Operating post is now square instead of hex and is supplied with a new type cushion ring and wearing ring. Available in cast iron, cast steel, bronze or semi-bronze. ¼ to 2-in. sizes will handle pressure to 250 lb.; 2½-in. size, pressure to 150 lb., and larger sizes up to 6 in. for lower pressures.

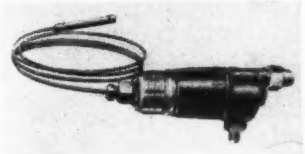
Everlasting Valve Co., 1 Montgomery St., Jersey City, N. J.



Lubricated Plug Valves

Plugs of these valves are held in place mechanically so that lubricant only affects pressure-type seal instead of lifting. Lubrication system in valve body provides complete seal at plug top, thus eliminating need for stuffing box. Ground and lapped surface between plug and body bearing, plus lubrication, provides ease of operation. Lubricating system comprises grease chamber in plug shank, cross channel in plug top, and grooves in valve body which surround ports completely.

Crane Co., 836 S. Michigan Ave., Chicago, Ill.



Thermostatic Expansion Valve

Detroit No. 673 thermostatic expansion valve, successor to the No. 671 American unit, extends the application of the dry evaporator to multiple systems, and also increases the efficiency of single evaporator or "unit" systems.

These valves are furnished standard with 0.078-in. orifice diameter, but on special order can be supplied with 0.125 or 0.156. The 0.078 orifice has a capacity of two tons of methyl chloride and one ton SO_2 or F-12. The larger orifices increase capacities 50 and 100 per cent, respectively, with high suction pressures and low-head pressures.

Detroit Lubricator Co., Detroit, Mich.

Elapsed Time Indicator

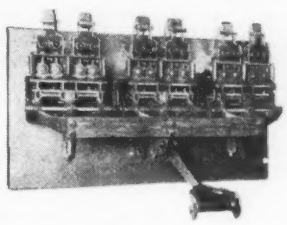
This elapsed time indicator for general purposes was designed for indicating the time a feeder circuit is out, but may be adapted as a lost-time indicator and for similar services. May be used with automatic reclosing device. Consists of a counter driven by a synchronous motor.

Automatic Switch Co., 6420 E. Lafayette Ave., Detroit.

Vertical Motoreducer

"MotoReduceR" is a compact reduction unit for agitators, mixers and other vertical drive. Minimum head room is required, and necessity of providing structural supports is avoided. Motor- and gear-operated, and is self-contained in one housing to avoid vibration and noise. Gears heat-treated nickel steel with helical cut teeth. Slow-speed shaft Timken mounted. Available in single, double and triple types at ratios up to 450 : 1, with standard open type or totally inclosed fan-cooled motors, polyphase and single-phase. Also available with d.c. motors up to 10 hp.

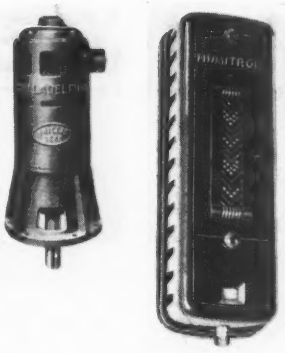
Philadelphia Gear Works, Philadelphia, Pa.



Air Circuit Breakers

Manually and electrically operated air circuit breakers, bearing the designation AL-2, are for control and protection of apparatus and feeders in buildings, industrials and power stations. Rated up to 750 volts and 10,000 amp., they are made in single-, double-, triple- and four-pole arrangements. Multipole breakers consist of two or more self-contained single-pole units mechanically interconnected. These breakers are trip-free, and can be equipped with instantaneous or time overcurrent trip, instantaneous or time undervoltage trip, shunt trip and auxiliary switches.

General Electric Co., Schenectady, N. Y.



Humidity Control

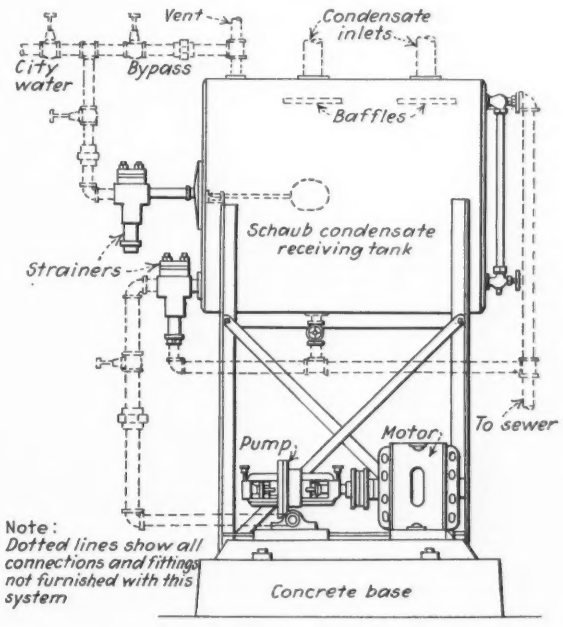
"Humitrol" closely controls operation of any equipment which may either add or withdraw moisture from air. Application is comparable to a thermostat in that hygroscopic, ribbon-type element expands or contracts as moisture content of air varies, and action is multiplied by a lever mechanism used to operate mercury tube switch. This switch starts or stops humidification or dehumidification equipment. Cover and base are of dark walnut Bakelite.

Lewis Air Conditioners, Inc., Minneapolis, Minn.

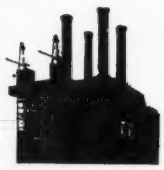
Boiler Return System

The "Schaub" boiler return system performs three operations automatically: Returns high- and low-pressure condensation, supplies make-up water to the boiler, maintains uniform water level in boiler. Incorporates special No. 332 automatic valve. Unit available in all sizes from 1 to 300 hp., for all working pressures from 5 to 150 lb. Larger sizes or higher working pressures upon application. Bulletin 632 describes the unit.

Fred H. Schaub Engineering Co., 325 W. Huron St., Chicago, Ill.



POWER LINES



A.S.M.E., A.S.R.E. Hold Annual Meetings At Time of New York Power Show

Three events of major importance in the power field are to be staged in New York during the coming three weeks. The first is the A.S.M.E. annual meeting, Dec. 5-10; the second, the meeting of the American Society of Refrigerating Engineers; and, the third, the Tenth National Exposition of Power and Mechanical Engineering. A program of the A.S.M.E. meeting was presented in the November number of *Power*, and that of the A.S.R.E. will be found on the next page. Preliminary information on the Power Show has been presented, and a number of the new items to be on display are illustrated in this number. Further new equipment items will be included in the Equipment Review & Summary of the Power Show to be mailed shortly after the Power Show has closed.

Products of 300 manufacturers of power and mechanical equipment are to be shown at the exposition, including: a three-element water-level control; a new type of temperature control designed to eliminate hunting; a differential draft-control system; and a new type of mechanical steam-flow meter. Two distinctly new types of expansion joints will also be shown for the first time, and a superheater developed for return-tubular boilers. Valves and fittings of alloy steels, and welded fittings and fusion-welded boiler drums will also be on display, as will an exhibit of chlorination methods to eliminate sliming of condenser tubes. Two new types of oil burners, one of the wide-range mechanical-atomizing type and the other the steam-atomizing type for burning refinery waste will be shown. Also a small pulverizer and an improved design of multiple-retort stoker. Other exhibits will show a device for removing free air from condenser circulating water; a new type vibration damper; and a hydraulic coupling for use between motors and fans.

Two especially noted leaders of American industry are on the program of the annual meeting of the A.S.M.E. General James G. Harbord is to be speaker at the banquet at the Hotel Astor, Wednesday, Dec. 7, and A. W. Robertson is to present the Towne Lecture. General Harbord is chairman of the board of directors of the Radio Corp. of America, and A. W. Robertson, chairman of the board of directors of Westinghouse Electric & Mfg. Co., and chairman by appointment of the President of the U. S., of the newly established Committee on Rehabilitation of Industry.

French Superliner Has World's Largest Motors

The four largest motors ever built for any purposes will propel the new French superliner "Normandie," which was launched at St. Nazaire, Oct. 29. These motors are rated at 40,000 hp. each, giving the new ship a total horsepower rating of 160,000, according to officials of General Electric Co. Four 34,200-kw. turbine-generator sets supply energy and operate on steam at 400 lb. pressure and 662 deg. F.

The previous record for motors was held by the two airplane carriers, U. S. S. *Saratoga* and *Lexington*. Eight motors, each rated at 22,500 hp. and connected two to each propelling shaft, are used to drive these vessels, with 45,000 hp. for each propeller. The airplane carriers, with 180,000 hp., still rank as the world's most powerful ships.

Supreme Court Decides Clarion River Power Case

The Supreme Court of the United States has rendered a decision in the Clarion River power case, by which the Federal Power Commission has established definitely its authority to regulate the financial structure of any holding company that may have, as a subsidiary, any power company operating under federal license. The Federal Power Commission thus is apparently planted squarely in the position of guardian to the investor in subsidiary companies, in the dealings between subsidiaries and their holding companies.

A.S.A. Approves Standards for Testing Lubricants

The American Standards Association has approved two new American Standards and four American Tentative Standards for Methods of Testing Petroleum Products and Lubricants. It has also approved the revision of an existing American Standard, and the Advancement of four American Tentative Standards to the status of American Standard. This action followed endorsement and submittal by the A.S.T.M. These standards were approved: Carbon Residue of Petroleum Products; Testing Gas Oils; Method of Test for Cloud and Pour Points of Petroleum Products; Method of Test for Melting Point of Petrolatum; Determination of Autogenous Ignition Temperatures; Flash Point of Volatile Flammable Liquids. The approved American Tentative Standards are: Expressible Oil and Moisture in Paraffin Waxes; and Definitions of Terms Relating to Petroleum.

COMING MEETINGS

10th National Power Show—Grand Central Palace, New York City, Dec. 5-10, during annual meeting, A.S.M.E. Conducted by International Exposition Co., Grand Central Palace, New York City. Charles F. Roth and Fred W. Payne, managers.

American Society of Mechanical Engineers—Annual meeting, New York City, Dec. 5-9. Secretary, Calvin W. Rice, 33 West 39th St., New York.

American Society of Heating & Ventilating Engineers—39th annual meeting, Hotel Gibson, Cincinnati, Ohio, Jan. 23-25, 1932. Headquarters, 51 Madison Ave., New York City.

American Society of Refrigerating Engineers—28th Annual Meeting, Hotel New Yorker, New York, N. Y., Dec. 7-9.

Gilbert Station Produces a Kw.-Hr. for 12,000 B.t.u.

Once more assuming its share in the production of power for the Pennsylvania and New Jersey groups of the Associated Gas & Electric System, the 1,250-lb., 55,000-kw. steam turbine in the Gilbert station of New Jersey Power & Light Co., Holland, N. J. (the most economical though not the largest of several stations feeding this system), has resumed the economical operation maintained ever since it started 2½ years ago. Aside from incidental repairs, the operation of this station was not interrupted until the summer of this year, when difficulties developed in the low-pressure unit. At the present time Gilbert station is producing a kilowatt-hour for about 12,000 B.t.u., or 0.888 lb. of coal. It is operating with a maximum output capacity of 55,000 kw., corresponding to an average at 43,000 kw. of sustained output, which practically represents its regular duty ever since it was started. Service was interrupted this summer for 71 days when the low-pressure units were shut down following evidences of excessive vibration. Examination disclosed a failure in the third-stage wheel of the low-pressure unit, which also had damaged the fourth-stage wheel.

A.S.H.V.E. to Meet in Cincinnati

The 39th annual meeting of the American Society of Heating & Ventilating Engineers is to be held under the auspices of the Cincinnati Chapter of the Society at Hotel Gibson, Jan. 23-25, 1933. A three-day program of business, technical papers and entertainment is being provided. Among papers to be presented are:

"Study of the Application of Thermocouples to the Measurement of Wall Surface Temperatures," by A. P. Kratz and E. L. Broderick; "Air Infiltration through Steel-Framed Windows," by D. O. Rusk, V. H. Cherry and L. Boelter; "Corrosion in Air-Conditioning Equipment and its Prevention," by R. M. Palmer; "Effect of Cold Walls on the Desired Effective Temperature for Comfort"; "Capacities of 1¼-in. and 2-in. Return Risers and Mains Carrying Water and Air in Different Percentages"; "Rate at Which the Return Side of a Practical Steam Heating System Returns Air and Condensate During the Heating-Up Period." Other subjects planned: "Refrigeration as Applied to Air-Conditioning"; "A Study of Residence Cooling in Summer"; "Oil Burner Performance"; "Heat Dissipation from Insulated Hot Water Piping and Smoke Abatement."

A.S.R.E. Meets in New York at Time of Power Show

Refrigeration, air-conditioning, heat transfer, lubrication, and a variety of plant and machinery problems will be discussed in technical papers before the 28th annual meeting of the American Society of Refrigerating Engineers, Dec. 7-9 at the Hotel New Yorker, New York, N. Y. The meeting coincides with the Tenth National Exposition of Power & Mechanical Engineering. Technical papers included are:

"Water as a Refrigerant," John Everetts, Jr.; "Comfort Cooling with Ice in 1932," George B. Bright, consulting engineer, Detroit, Mich.; "Air-Conditioning Theory: Classroom Methods of Presentation," J. A. Goff, assistant professor, Mechanical Engineering Dept., University of Illinois; "Ebullition of Refrigerants," L. A. Philipp, head of research division, Kelvinator Corp.; "Film Coefficients of Boiling Liquids," Dr. Cryder, Pennsylvania State College; "Absorption of Heat from Solar Radiation as Affected by Types of Surface in a Structure," professors F. G. Hechler and E. R. Queer, Pennsylvania State College; "Cold Storage and Warehouse Refrigeration," W. E. Zieber and J. C. Consley, York Ice Machinery Corp.; "Bearing Characteristic Curves for Fluid Film Lubricated Journal Bearings," L. J. Bradford and C. C. Davenport, Pennsylvania State College; "New Equipment in Solidification of CO_2," J. C. Goosmann, Dry Ice Corp. of America; "CO_2 Cycles and the Power Requirements in Production of the Solid," A. B. Stickney, Fred Ophuls & Associates; "The Truck Refrigeration Problem," P. T. Sealey, Reid Ice Cream Corp.; "The Design and Market for Gas Refrigerators," H. M. Williams, Frigidaire Corp.; "Production Layout of Cabinet-Making Plant," H. J. Gerlach, General Electric Co.

New River Development

A license has been issued by the State of Virginia for the proposed hydro-electric development on the New River in Pulaski County, near Radford, to the Appalachian Electric Power Co. Federal intervention will still prevent the construction of the development despite the State corporation commission's license. Although exempt from the provisions of the Virginia waterpower act of 1928, the Appalachian company voluntarily submitted a petition for a license recently under an amendment of the act passed by the 1932 general assembly. The Federal commission has refused to issue a "minor part" license for the project, and forbids the Appalachian company to proceed with the construction until a "major" license, providing for full Federal regulation, is obtained. Plans for the hydro dam, which, it is estimated, will represent an investment of $12,000,000, were originally laid prior to 1926. More than $1,500,000 has already been spent by the company on the development. Actual construction has been prevented by the failure of the Federal power commission to allow the company to proceed.

Welding Course

Success of the combined practical and theoretical one-week welding course offered by John Huntington Polytechnic Institute, Cleveland, in cooperation with the Lincoln Electric Co., has led to the decision to repeat the course several times during the winter season. It consists of a week's intensive work, six days being spent in the operator's training school of the Lincoln company, and five lectures on designing for arc-welded construction being given at John Huntington Institute. Enrollment is limited to 30 men and applicants must be college graduates in engineering or have equivalent practical experience.

N.E.L.A. Announces Prizes for Power Papers

The National Electric Light Association has announced that it is to award a number of prizes to individuals and companies for papers on subjects relating to electric light and power industry and also for accomplishments in specified activities.

The Doherty prize is awarded for the most meritorious paper on any subject relating to the electric light and power industry; Byllesby prizes for the three most meritorious papers showing how to increase usefulness of the accountant in the public utility industry; the Davidson prize for the three most meritorius papers relating to commercial or merchandising problems of the industry, particularly with campaigns to promote electric service and merchandising sales; the Forbes prize for the most meritorious paper dealing with the subject of public relations in the industry; the Lindemann prize for the three most meritorious papers by employees dealing with advantages of electric cookery for domestic purposes; and the McGraw prize for the three most meritorious papers on any engineering or technical subject relating to the industry. Prizes to companies include: the Curtis prize for lighting of buildings; the Gilchrist prize for electrical advertsing; and the Martin price for rural electrification. The Hughes prize is awarded to the company showing the greatest contribution to the development of the domestic electric cookery load during 1933.

Papers and exhibits for prizes must be forwarded by Mar. 1, 1933, to the secretary, N.E.L.A., 420 Lexington Ave., New York, N. Y.

Chicago Power Show Begins June 25, 1933

The Sixth Biennial Chicago Power Show will be held in 85,000 sq.ft. of exhibit space at the Coliseum beginning June 25 of next year. The Chicago World's Fair, which opens June 1, and Engineering Week, beginning June 25, will see more than 14 prominent national engineering societies gathered in Chicago for major meetings, thus making the exposition the largest that has been held in Chicago. Further information may be obtained from G. E. Pfisterer, director, Midwestern Engineering & Power Exposition, 308 W. Washington St., Chicago, Ill.

Rulings Announced On Electrical Energy Tax

Several important rulings have recently been announced by the Tax Department with respect to the 3 per cent tax on electrical energy. The following is a digest of some of these rulings prepared by J. S. Seidman, tax expert of Seidman & Seidman, certified public accountants:

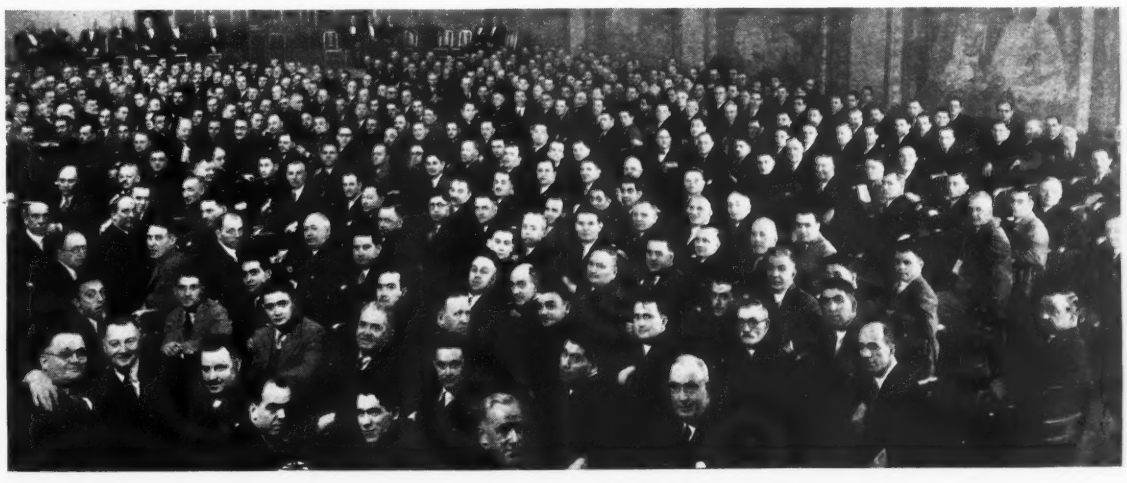
1. Electrical energy furnished to meat-packers for the processing of meat products is not subject to tax. However, energy used for refrigeration, storing, or so-called aging of fresh meats, or distribution of the products, is held to be for commercial use and therefore taxable. When both operations are carried on at one location by means of electrical energy furnished through one meter, the predominant character of the business will determine the taxable status.
2. The use of electrical energy by bottling works, milk companies, or creameries engaged in the pasteurization and bottling of milk and in the manufacture of butter, buttermilk, chocolate milk and cotage cheese, is not taxable.
3. Where the predominant character of a grain elevator business is the purchasing of grain for resale, and the storage of grain for the account of the producer, and no processing of a substantial nature is carried on, electrical energy furnished to the elevator is taxable. However, electricity used for cleaning, drying, grinding, and bleaching grain is industrial in scope, and hence not taxable.

Inch-Millimeter Conversion

An American standard value to be used by industry in converting inches to millimeters was recommended by a general conference under the auspices of the American Standards Association recently. The conference unanimously recommended the conversion factor of one inch equals 25.4 mm. to become the American Standard.

GOLDEN JUBILEE

Eastern N.A.P.E. members meet at Hotel New Yorker, New York, N. Y., Oct. 25, to honor past presidents and to observe fiftieth birthday of the association.



OBITUARIES

IRVING FELLNER, 41, who had been connected with the McGraw-Hill Publishing Co. in an executive capacity for many years, first with *Chemical & Metallurgical Engineering,* then with *Power* as publishing director, and, at the time of his death, with *Management Methods,* died suddenly as the result of an accident Oct. 30 at his home in Chappaqua, N. Y. During the World War, Mr. Fellner served overseas as captain of infantry with the 30th Division. He was an active member of the A.S.M.E. and other associations.

OLAF N. GULDIN, 83, nationally known gas engineer and for 30 years president of the Western Gas Construction Co., Fort Wayne, Ind., died at his home there after a long illness.

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PERSONALS

ELLIOTT EARL, consulting engineer of Boston, Mass., spoke on "The High-Speed Diesel Engine as a Prime Mover for Pumping Stations" at a meeting of the New England Water Works Association in Boston, Nov. 9. Mr. Earl was formerly research assistant of the Engineering Experiment Station, Penn. State College, Pa.

R. C. CUTSHAW has been appointed sales manager of Godfrey Conveyor Co., Elkhart, Ind. He was previously employed by the company in a sales capacity and more recently resigned as eastern sales manager of Gifford-Wood Co.

DR. IRVING LANGMUIR, associate director of the General Electric Research Laboratory, will receive, Dec. 10, the Nobel Award in Chemistry for 1932. He is the second American to be so honored.

F. M. STARR of the central station engineering department, General Electric Co., Schenectady, N. Y., has been awarded the Alfred Nobel prize for his paper "Equivalent Circuits," presented at the winter convention of the A.I.E.E. in New York City last January.

R. L. FOOTE has resigned from the Marine Sales Division of Westinghouse Electric & Mfg. Co. to become New England representative for Condenser Service & Engineering Co. and Instrument Service Co., both of Hoboken, N. J. His office will be at 7 Water St., Boston, Mass.

HARRY B. SEWALL, for fourteen years manager of the Puget Cound Power & Light Co.'s northern district, has been transferred to Seattle, where he becomes manager of purchasing. W. M. BIRD, division manager in Seattle, succeeds Mr. Sewall.

DR. WILLIS RODNEY WHITNEY, organizer and for 32 years director of the research laboratory of General Electric Co., retired from that position owing to poor health Nov. 1. He was succeeded, by appointment of Gerard Swope, president, by Dr. William David Coolidge, senior associate director of the laboratory. Dr. Whitney continues as vice-president in general charge of research.

H. C. PARMELEE, vice-president and editorial director, McGraw-Hill Publishing Co., has been appointed a member of the National Research Council, on the Division of Engineering and Industrial Research, for three years.

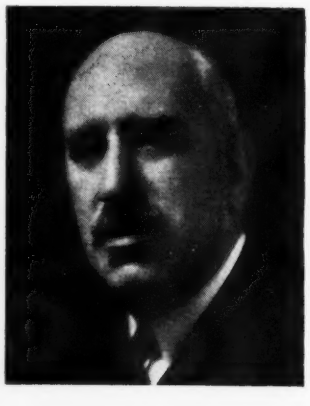
COL. HUGH L. COOPER, chief consulting engineer on the Dneprostroy hydro-electric project, the largest in the world, has been awarded the Order of the Red Star, one of the highest decorations bestowed by the Soviet Government. Six members of his staff received the Order of Lenin at the same time.

J. S. TRITLE, vice-president and general manager of Westinghouse Electric & Mfg. Co., has been elected president of National Electrical Manufacturers' Ass'n to succeed John T. Trumbull, former Governor of Connecticut.

H. K. KUGEL, formerly acting commissioner of Smoke Inspection for the City of Cleveland, is now combustion engineer for the Board of Education, with purchase, inspection and economical burning of coal for 155 school buildings of the city under his jurisdiction. A large proportion of the coal is high volatile from the Ohio mines, and all sorts of equipment, including cast-iron and water tube boilers, hand-fired and otherwise, with down draft and overdraft, is used.

CHARLES M. SCHWAB, past-president of the A.S.M.E., received the Melchett Medal for 1932 in London, England, on Oct. 19 at the annual dinner of the Institute of Fuel. It was presented by Lady Melchett, widow of the donor, in recognition of Mr. Schwab's work in the development of the iron and steel industry and his economic use of fuel in that connection.

W. S. SHIPLEY, president of York Ice Machinery Corp., has been elected president of the Refrigerating Machinery Association. The announcement was made at the Society's 19th Annual Meeting in the Book-Cadillac Hotel, Detroit, Mich., recently. Next scheduled meeting of the R.M.A. will be at Hot Springs, Va., during the third week in May, 1933.



BUSINESS NOTES

A. & H. MILLER, INC., has been appointed sales representative and distributor for Mathieson anhydrous ammonia, manufactured by Mathieson Alkali Works, Inc., Niagara Falls, N. Y., and for Wyandotte calcium chloride, manufactured by Michigan Alkali Co., Wyandotte, Mich., for the New York territory. Offices are at 370 Lexington Ave. at 41st St., New York, N. Y.

FOOTE BROS. GEAR & MACHINE CO., 215 N. Curtis St., Chicago, Ill., has appointed Urquhart Service, 2133 Blake St., Denver, Colo., as representative in Colorado and Wyoming to replace S. Howard Eisenberg. Foote Bros. has also increased the territory of Briggs Schaffner, Winston-Salem, N. C., from the Winston-Salem territory to the States of North and South Carolina.

MAINTENANCE ENGINEERING CORP., Houston, Tex., has appointed A. J. Hooper as sales engineer to assist in promotion of more technical specialties for power plants, refineries and pipe lines, particularly water-conditioning in connection with Hall Laboratories, Inc., Buromin Co., and Hagan Corp., of Pittsburgh.

EMIL GREINER CO., New York, N. Y., manufacturer of instruments, laboratory glassware and apparatus, has appointed Maintenance Engineering Corp., Houston, Tex., as representative in that district.

ALONZO B. REED, engineer of Boston, has moved to Room 811, 89 Broad St., Boston.

JEFFREY MFG. CO., Columbus, Ohio, has moved its Southwestern branch office from Houston to Dallas, Tex. T. P. Burke continues as manager.

IMPROVED INDUSTRIES CORP., 521 Fifth Ave., New York, N. Y., has been formed to finance, without notes, in whole or in part the purchase, by industrial plants, of equipment where improved operation and money saving will result, according to its president, R. G. Macy. Power plant modernization plans now held up for lack of funds may thus be expedited.

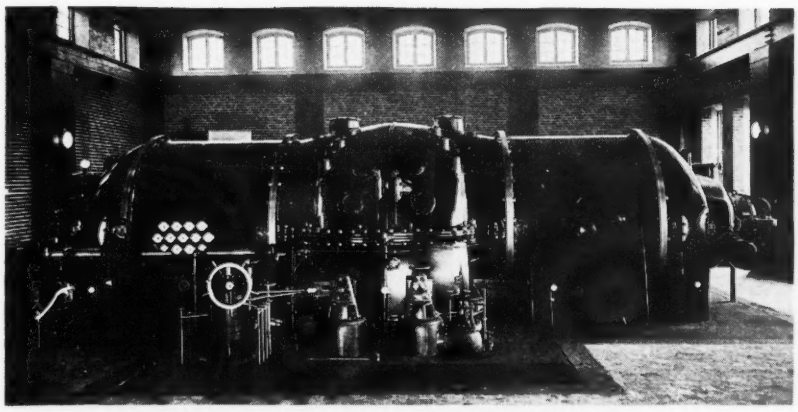
COMBUSTION ENGINEERING CORP., 200 Madison Ave., New York, N. Y., announces that it will continue the practice of lending slide lectures on "Boilers" and on "Fuel Burning Equipment for Modern Steam Plants" to any technical society, club or institution.

ENGINEER'S SPECIALTY CO., 549 West Randolph St., Chicago, Ill., has purchased the clutch business of Columbia Industrial Machinery Co.

MOLOCH FOUNDRY & MACHINE CO., Kaukauna, Wis., formerly the Moloch Co., which specialized in the manufacture of large industrial types of stokers, has developed and is manufacturing a complete line of domestic, commercial and light industrial underfeed stokers of the screw type.

STACEY BROS. GAS CONSTRUCTION CO., Cincinnati, Ohio, has moved its New York office to 24 State St., New York, N. Y. Wm. S. Guitteau continues as eastern manager.

G. J. STURMFELSZ has been appointed representative in the Baltimore district of Falk Corp., Milwaukee, Wis. His offices are at 1620 E. 32nd St., Baltimore. H. Douglas Stier, 101 Marietta St., Atlanta, Ga., has been appointed Falk representative in that district.



Scandinavia's largest prime mover, this 50,000-kw. Ljungstrom turbine in the State Power Station at Vasteras, Sweden, is also the world's largest of the double-rotating type. Steam expands radially instead of axially and a world record turbine efficiency of 90.3% is reported. Total weight 510 tons, rotating parts 52 tons, length equal to that of a 15,000-kw., 3,000-r.p.m. axial turbine

STRAWS

Pointing the way the business wind blows

Applications for loans under the self-liquidating provisions of the Emergency Relief & Construction Act aggregate more than a billion dollars, according to the American Engineering Council. Self-liquidating loans totaling $134,633,500 have already been approved. Class I applications total $135,796,653 and cover 64 projects. Thirty, aggregating $3,309,120, are for construction of water supply systems, and five are for power plants totaling $6,859,000. Class 2 applications, those that are incomplete and informal, number 42 and aggregate $189,051,520. They include: 16 water supply systems at $20,484,000, and five power plants at $32,670,000. Class 3 applications, those which are informal and are accompanied by little or no data, total 87 and involve $385,522,257. They include: 39 water supply systems at $36,439,257; 4 power plants at $980,000.

Establishment of a new hydro-electric plant to serve Creston, B. C., and adjoining districts is now practically assured as the result of negotiations carried out by Col. Fred Lister, M.L.A. for Creston, with the Provincial Lands department of the B.C. Government. The installation is estimated to cost about $40,000. It will be a development of Summit Creek to amount to an initial 200 hp.

Titusville Iron Works Co., 20 N. Wacker Drive, Chicago, Ill., has received a contract from N. P. Severin Co. Chicago, for boiler equipment, including 14 large boilers, for the new government buildings at Minneapolis, Newark, and Rochester, N. Y.

The Navy Department, Bureau of Supplies & Accounts, has asked for bids on a diesel engine with spare parts to be delivered to San Diego. Bids were opened Nov. 15.

A large Eastern manufacturer of leather belting and leather products reports that all divisions of his business have picked up.

General Electric Co. was awarded the contract for the 35,000-kw., 1,800 r.p.m., turbine for the Buzzard Point Station of Potomac Electric Power Co. It will operate at 650 lb. and 825 deg. F.

Nearly $71,000,000 has been pledged by a number of companies reporting to the national committee on industrial rehabilitation as available for modernization and expansion programs to be begun at once. The A. T. & T. Co. with a modernization program involving $35,000,000, and Standard Oil Co. of New Jersey planning $20,000,000 for improvements, head the list. In addition to those previously reported in this column, Montana Power Co. will expend $100,000 for a new absorption plant and refinery, and a number of other companies are building new manufacturing plants.

Fraser Valley, B. C., has installed pumps taking 5,700 hp. in electricity to drain dyke farm lands. The Sumas dyking scheme uses 3,500 hp.; Dewdney scheme, 500 hp.; Matsqui, 685 hp.; Pitt Meadows, Maple Ridge and Coquitlam, 650 hp. In addition to those named, there are smaller pumping systems on Nicomen Island and West Langley, and a scheme has been proposed for Lulu Island.

Operation of its own electric generating plant for street lighting purposes is now being considered by the Victoria City Council. Lease of the B.C. Electric Railway Co. and its subsidiaries on Goldstream water shed properties near Victoria terminates in 1938. The city will then be in a position to acquire the plant and property.

Settlement of a long drawn-out dispute over power rights in British Columbia has been reached between the city of Grand Forks and the Provincial Government. The government has decided to transfer formally its water license to Grand Forks city.

West Kootenay Power & Light Co. has decided to develop its electric power resources on Goat River in the vicinity of Creston, B. C. The plan for a 140-ft. head has been abandoned and a 70-ft. head of water will be used.

"Positions Available" listed in the weekly issues of the A.S.M.E. News have increased from one or less each week to seven or eight weekly.

The Ontario Hydro-Electric Power Commission is acquiring the Abitibi Canyon power development in Northern Ontario and an immediate start on the work of completing construction is anticipated. An order-in-Council has been passed by the Ontario Government guaranteeing the $18,000,000 worth of 20-year debentures which the Hydro will exchange for $20,000,000 in Ontario Power Service Corp. bonds under the terms of the transaction.

Anticipating modification of the Volstead Act, the Blatz Brewing Co., Milwaukee, Wis., has developed plans for expansion of production and distribution facilities, involving a total expenditure of $2,000,000. Anticipated construction projects include a new boiler house.

Reconstruction Finance Corp. on Nov. 1 O.K'd a loan of $1,476,000 for the Maverick County Water Control District No. 1 of Eagle Pass, Tex., for repair and construction of a combined irrigation and power project.

Englewood, Colo., adjoining Denver on the South, has decided upon municipal ownership of its water and power plants.

New generating equipment costing $60,000 is now supplying electrical power to residents of the Alberni and Port Alberni districts of Vancouver Island, B. C., following final tests. The new equipment doubles power available to residents of the district, and consists of a McIntosh & Seymour 5-cyl., 4-cycle, 565-hp. diesel, direct-coupled to a 500-kva. Westinghouse generator. The old equipment is two diesels of 300 and 150 hp., and a small waterwheel 120 hp., operated with surplus city water. The diesels will be thoroughly overhauled immediately.

The city manager of Lynchburg, Va., has recommended that the city council begin an investigation looking to the establishment and maintenance of a municipal electric light plant to cost upward of $1,000,000.

The new 32,500-kw. unit of the Pasadena, Calif., municipal light and power department's steam generating station will be placed in service about Dec. 1. The new unit will bring station generating capacity to 60,000 kw.

Public Service Co. of Colorado's major enterprise for 1932, a 3,000-kw. hydro-electric plant on the Colorado River, near Palisade, Colo., is in process of completion and will be supplying energy for Western Slope territory by Jan. 1 of next year. The new plant, known as Grand Valley Power Plant, will operate under a 73-ft. head of water and have available 800 second feet except during irrigation seasons when this supply will be halved. Two plate steel penstocks, 78 in. in interior diameter and 230 ft. long, will be used to connect the two 2,300-hp. turbines with water supply. The company will operate the plant in conjunction with its three neighboring units, two steam and one hydro.

New Bulletins

FUSION WELDING —Part IV of A. J. Moses' article entitled, "History and Developments in the Art of Welding Ferrous Metals" describes welding of pressure vessels and is available in reprint form from Hedges-Walsh-Weidner Co., Chattanooga, Tenn.

EVERDUR METAL—Application of Everdur as a material for tanks and pressure vessels is described in a new pamphlet by American Brass Co., Waterbury, Conn.

VACUUM PUMPS—Bulletin 21-B22 of Roots - Connersville - Wilbraham, Connersville, Ind., covers application of R-C-W vacuum pumps of different types in priming centrifugal pumps, especially large sizes. Bulletin 21-B23 covers application of Victor-Acme blowers to blowing units in specialized service.

INDUSTRIAL THERMOMETERS—Catalog No. 101 of H. O. Trerice Co., 1420 W. Lafayette Blvd., Detroit, Mich., describes the company's industrial thermometers and similar products.

CONDENSING & COOLING SECTIONS—National Radiator Corp., Johnstown, Pa., has issued Report CP-6, describing design and construction of the company's condensing and cooling sections and giving the results of comparative tests on these sections with sections of the conventional type.

COLLOIDAL GRAPHITE — Acheson Oildag Co., Port Huron, Mich., has issued Technical Bulletin No. 103.3 on "Colloidal Graphite as a High-Temperature Lubricant."

DISCHARGERS—Bulletin 694, of Cochrane Corp., North Philadelphia P.O., Philadelphia, Pa., describes the Cochrane discharger, a pilot-operated steam trap, which differs from ordinary steam traps in that two solid displacement bodies mounted upon an oscillating beam are used instead of a float to operate a pilot valve which admits steam to a cylinder containing a plunger or piston which actuates the main or discharge valve.

ELECTRIC HOIST — Philadelphia Gear Works, Erie Ave. & G St., Philadelphia, Pa., has issued a bulletin describing the new Philadelphia electric hoist.

LIQUID FLOW METERS—Isometer Co., 2357 N. 29th St., Milwaukee, Wis., has issued a booklet, "The Isometer for the Accurate Measurement of all Liquid Flows."

STOKER UNIT—Type E Stoker-Unit of Combustion Engineering Corp., 200 Madison Ave., New York, N. Y., is described in a new pamphlet. The unit is applicable to boilers from 40 to 150 developed boiler horsepower.

UNDERFEED STOKERS—Riley Stoker Corp., Worcester, Mass., has issued a catalog describing the Riley Model "R" Multiple Retort-Underfeed Stokers.

UNIT HEATERS—Murray Iron Works Co., Burlington, Iowa, has developed a new line of unit heaters with either motor or steam-turbine drive, described in Bulletin T-112.

WATER SOFTENERS—Permutit Co., 440 Fourth Ave., New York, N. Y., has issued "No Scale, No Sludge, No Mud, The Application of Zeolite Water Softeners to the Treatment of Boiler Feed Water."

BEARINGS—Bulletin S of Kingsbury Machine Works, 4324 Tackawanna St., Philadelphia, Pa., is for designers who have occasion to employ Kingsbury bearings in machinery for horizontal shafts, such as centrifugal pumps. It contains dimension lists and capacities of three types of mountings of combined thrust and journal bearings, and similar data on mountings for independent journal bearings.

TREATMENT OF FEEDWATER—N.E.L.A. has issued this bulletin, containing information on caustic embrittlement, carryover, practical methods of water control, troubles, operating company statements and manufacturers' statements as N.E.L.A. publication 235. Price, $0.40 for members; $0.60 for non-members.

A.S.M.E. BOILER CONSTRUCTION CODE—The American Uniform Boiler-Law Society, 253 Broadway, New York, N. Y., has issued Data Sheet No. 4 giving the status of the 1931 A.S.M.E. Boiler Construction Code giving tabulated information for various states and cities and indicating the aims of the Society.

BOILER EXPLOSIONS—The 1931 memorandum by the engineer-in-chief of the Manchester Steam Users' Association describes prevention of steam boiler explosions and the attainment of economy in steam application. Copies are available from the Association at 20 Quay St., Deansgate, Manchester, England.

New Plant Construction

McGraw-Hill Business News Department Is Prepared to Furnish a More Complete Daily Service

Ark., Humphrey — City preliminary plans waterworks and distribution system, incl. wells, pumping equipment, tank on tower and mains, etc. Engineer not appointed.

Calif., Glendale—City Council instructed City Manager and Comptroller to submit report on proposal of a group said to represent a midwestern syndicate to finance and build a municipal electric generating plant for city, capable of reducing 35,000,000 kwh. annually.

Colo., Fort Collins—City, c/o Mayor, sketches municipal light and power plant and distribution system. $700,000. Burns & McDonnell Eng. Co., 406 Interstate Bldg., Kansas City, Mo., engrs.

Colo., Sterling—Public Service Co. of Colorado, Denver, affiliate of Cities Service Co., 60 Wall St., New York, rebuilding generating plant, damaged by fire.

D. C., Wash.—Bids Dec. 1, by Treas. Dpt. at office Sup. Archt., Wash., D. C., construcing (except boilers, stokers and forced and induced draft fans) for Central Heating Plant for Public Buildings.

Fla., West Palm Beach—Co-operative Company G. W. Moore, chn., c/o Riviera Fish Co., Riviera, plans ice plant, $60,000.

Idaho, Wallace—Federal Mining & Smelting Co., 120 Bway., New York, repairing and rebuilding generator plant vicinity of here. **Maturity indefinite.**

Illinois—State, Div. Hys., 220 South State St., Chicago, plans water power plants to generate electricity at Brandon Road, Dresden Island and Starved Rock, Great Lakes to Gulf Waterway. Recommended by U. S. Engineers, War Dept.

Ill., Alton—Committee, J. J. Brenholt, Jr., chn., considering advisability of city owning its electric light and power, gas and waterworks and distribution system. The franchises of Alton Water Co., also Alton Gas Co., subsidiary of Union Electric Light & Power Co., have many years to run. Consulting engineer firm advised city that light and power plant to supply city's domestic and commercial use also street lighting could be built at cost $1,200,000.

Ill., North Chicago—City M. Opeka, clk., voted to start negotiations for loan from Reconstruction Finance Corp. and requests bids from engineers on estimated cost of surveying city for proposed installation electric plant.

Ill., Chicago—German Government, Berlin, Germany, plans 2,000 ft. high giant wind power tower, steel, concrete pile found., with five 360 ft. wheels to produce 80,000 hp. for Century of Progress.

Ill., New Lenox—Municipality plans pumping station, pumping equipment. $10,000.

Ind., Brazil—City, F. K. DeArmay, clk., plans electric light plant. $660,000. Burns & McDonnell Co., 417 East 13th St., Kansas City, Mo., engrs.

Ind., Mishawaka—City Council plans municipal light plant. $415,000. Will employ engineers to make estimate for construction of same.

Ia., Corning—City, V. J. Mack, clk., voted on proposition to build light and power plant. $160,000. Engineer and architect not appointed.

Ky., Marion—City plans application for loan to Reconstruction Finance Corp. impounding reservoir, filter plant, pumping plant and supply line, H. K. Bell, Lexington, engr.

Mass., Worcester—Independent Ice Co., 30 Charles St., addition to ice manufacturing plant, Madison and Gold Sts. To exceed $40,000.

Mich., Alpena—City preliminary plans and estimate of cost complete municipal electric plant and distribution. $60,000. This is a preliminary report incl. valuation of distribution system owned by Alpena Power Co. Francis Eng. Co., Saginaw, consult. engrs.

Mich., Ecorse—Murray Corp. of America, Clay Ave., Detroit, completing plans 2 story, brick, steel, concrete boiler plant for addition to automobile body plant. $35,000. Private plans.

Mich., Petoskey—City, P. T. Mitchell, mgr., concrete, earth dam across Bear River to provide third city-owned hydro-electric power plant, city forces. Power plant to be constructed upon completion of dam, also heavy service lines are to be rebuilt and extended throughout the city.

Minn., Elk River—Municipality, election Dec. 6, $100,000 bonds municipal electric light and power plant. R. W. Richardson, 419 New York Bldg., St. Paul, engr.

Mo., Maplewood—City Council is considering proposal that the city construct and operate municipal light and power plant. $500,000.

Mo., St. Charles—City Council rejected city ordinance calling for special election $300,000 bond issue for municipal light and power plant.

N. M., Fort Stanton—Treas. Dept. at office Sup. Archt., Wash., D. C., 1 new hospital ward unit, power house, laundry building, nurses home and officers quarters, at U. S. Marine Hospital. $275,000.

N. M., Hillsboro—El Oro Mines Co., sketches 300 ton milling plant and 1,000 hp. diesel power plant. $150,000. C. J. Hutchinson, Hillsboro, mgr.

N. Y., Brooklyn—Bu. Yards & Docks, Navy Dpt., Wash., D. C., improving power plant, separate contracts and day labor. $565,000. **Maturity soon.**

N. Y., Buffalo—Treas. Dpt. at office Sup. Archt., Wash., D. C., remodeling present building and constructing additional buildings, incl. power house and nurses' quarters at U. S. Marine Hospital, Main St. and Florence Ave. $250,000.

N. Y., Pitcairn—Harrisville Electric Light & Power Co., Harrisville, granted permit by Pub. Serv. Comn. to construct electric plant here and transmission lines in Diana. $18,000 or more.

N. C., Banner Elk—Lees-McRae College, E. H. Tufts, pres., Banner Lake, plans storage lake for power development, incl. new dam and water supply.

N. C., Lexington—City, considering application to Reconstruction Finance Corp. for loan to construct municipal power plant. J. A. Smith, mayor.

Okla., Hominy—City, W. R. Brady, clk., soon takes bids brick, concrete power plant, equipment. $150,000. V. V. Long & Co., 1300 Colcord Bldg., Oklahoma City, engrs.

Pa., Carlisle—Con. Q.M., Carlisle Barracks, heating plant, at Carlisle Barracks. $180,000.

Tex., Gatesville—City, c/o Secretary, light and power plant. $60,000. Montgomery & Ward, Wichita Falls, engrs.

Man., Winnipeg — Manitoba Power Comn., Notre Dame St. E., making plans extending Provincial Hydro-electric System to Grand Beach and Victoria Beach. Address J. Gordon, ch. engr. Electrical Dpt., Canadian Ntl. Rys.

Ont., Tillsonburg—Town Council plans to submit a bylaw Dec. 5 for erecting, equipping artificial ice arena. $50,000. Interested in prices and information regarding artificial ice equipment. W. J. Shearing, chn. building com.

Ont., Toronto—City plans under way for pumping stations at Victoria Park Ave. and at Sunnyside in connection with duplicate waterworks scheme, involving electric pumps, 3 stage, centrifugal to handle 100,000,000 gal. Est. $250,000. R. C. Harris, City Hall, engr.

Equipment Wanted

POWER and PUMPING EQUIPMENT—**Los Angeles, Calif.**—Metropolitan Water Dis. to purchase 2 5,000-kva. syn. condenser; 8 34.5-69 kv. and 11 7.5-15 kv. circuit breakers, 12,34.5-69 kv. air switches 50 69-kv. disconnecting switches, 25 34 kv. disconnecting switches, 20 11.5-kv. disconnecting switches, 8 35-kv. potential transfrms., 18 15 kv. current transfrms. 32 100-300 g.p.m. booster pumps for 50- to 1,000-ft. lift with 32 motors for drive.

TURBINE or ENGINES—**Glendale, Calif.**—City plans steam turbines or diesel engines 55,000,000 kw. hrs. per annum, for municipal power plant.

PUMPING UNITS—**Wash., D. C.**—U. S. Eng., 4 vertical motor driven pumping units for booster pumping plant, Washington Aqueduct.

LOW LIFT PUMP, etc.—**Owingsville, Ky.**—City soon takes bids 1 low lift and 1 high lift pumps, 175,000 gal. tank on tower, 2, 6 and 8 in. c.i. mains, etc. Churchill & Gillig, engrs.

POWER PLANT, etc.—**Reno, Nev.**—Monarch-Gold Ledge Mines, 41 Clay Peters Bldg., C. E. Basso, pres. and mgr., in market diesel power plant, electric generator, 50 ton capacity mill, electric hoist and air compressor for mine 3 miles south of Eastgate.

DIESEL ENGINES—**Egypt, Cairo**—Bids Dec. 10, by Ministry of Interior, supply and erection two 100 hp. 4 stroke, diesel engines; two 80 kva. 3 phase, flywheel alternators to generate 3,150 volt 50 cycle; air switchgear, pumping sets, oil storage, reservoir, lubricating oil recovery plant, reservice compressor and traveling crane, all for Bouch Power Station.